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## LARYNGEAL CARCINOMA

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### INTRODUCTION

It is the discovery of the laryngoscope in 1855 that laid the foundations for the accurate study of laryngeal cancer clearly marking it off from the granulomas. Primary cancer of the larynx, however, continued to be regarded as a rare disease and it took some decades more before it was recognised that intrinsic disease preponderated over the extrinsic cancer of the larynx. This was mostly possible due to the work of Butlin and Semon. Here are some published figures<sup>1</sup>

	Intrinsic	Extrinsic	Total
Semon	136	76	212
Chevalier Jackson	98	43	141
Gabriel Tucker	144	56	200
Schmiegelow	36	12	48

### FREQUENCY

It is still generally true to say that cancer of the larynx is uncommon as compared to the occurrence of carcinoma in other parts of the body.

In England, out of every 100 deaths from cancer 21 are of the stomach, and 1.8 of the larynx. In U.S.A. there is one death from laryngeal carcinoma to forty from carcinoma of the stomach.<sup>2</sup>

From a study of the number of in-patients treated in the King George Hospital, Vizagapatam, for malignant tumours during the period from 1936-40 it is found that 29 cases i.e., 2 per cent were of the larynx and laryngopharynx and 61 i.e., 4 per cent of the oesophagus and stomach out of a total of 1499. The 2 per cent of laryngeal carcinoma closely corresponds to the English figures. But the incidence of gastric carcinoma appears to be strikingly low as compared with its death-roll varying from 21 per cent in England to 66 per cent in Czechoslovakia.

Secondly, it has been noticed both in England and America that not only there has been in recent years an increase in the mortality from cancer in general but that relatively and actually carcinoma of the larynx is on the increase.<sup>3</sup> This is, of course, after correction was made for the average increase in the age of the population. The increase in cancer mortality is perhaps partly explainable by reason of more accurate registration. It would be interesting to investigate the

relative incidence of cancer in India but registration of deaths here as yet cannot be relied upon as of any real scientific value.

### CLASSIFICATION

It is now more than half a century since Krishaber proposed the classification of laryngeal carcinomata into extrinsic, intrinsic and mixed types. It has served to separate a group of growths confined to the interior of the larynx, of slow progress, remaining localised for a long time and very amenable to treatment, from those arising from the margins and posterior surface of the larynx whose onset is insidious, progress comparatively more rapid and attended with early glandular metastases. In spite of this clearly defined classification there has been some confusion and vagueness both in the application and interpretation of the terms intrinsic and extrinsic with reference to the carcinoma of larynx. St. Clair Thompson<sup>4</sup> observed in 1939 that cancer rarely originates in the ventricular bands or the interarytenoid region but that the ventricle and subglottic region do give rise occasionally to malignant growths and therefore suggested that we should limit the term 'laryngeal cancer' to manifestations of this disease around the glottis, and give the title 'cancer of the hypopharynx' or 'laryngopharynx' to the various manifestations which have been vaguely grouped together as extrinsic cancer of the larynx. This is also in accordance with the views of Wilford Trotter<sup>5</sup> and the American laryngologists, New and Figg,<sup>6</sup> McReady<sup>7</sup> and others. I prefer this classification to the older one. Disease of the epiglottis need not perhaps be considered as separate entity by itself as proposed later by St. Clair Thomson himself in 1939<sup>8</sup>.

The number of patients suffering from malignant growths of the larynx and the laryngopharynx admitted in the Ear, Nose and Throat Department of the King George Hospital, Vizagapatam, during the course of last 15 years is only 75. As such my experience is very limited but for a disease which is so uncommon I think it is worth while placing it on record.

Cancer of the larynx was discovered in 12 cases and cancer of the laryngopharynx in 63 cases. Of the latter, from a study of their history and symptomatology, six cases appeared to be intrinsic or primarily laryngeal but became extrinsic or laryngopharyngeal by extension. These were called 'mixed' according to the older classification of Krishaber. Even then incidence of a total of 18 cases of laryngopharyngeal disease is at a considerable variance with the experience of the great authorities already cited. It would appear however that the figures cited by them related mostly to the private cases whereas the figures furnished by me are entirely of the



hospital So far as the hospital experience goes, the largest number first seen appear to be in the extrinsic stage even in the West

St Clair Thomson<sup>10</sup> cites, "in Philadelphia General Hospital not one was limited or suitable for a laryngofissure in a series of 75 cases"

MacKenty<sup>11</sup> says, "for some unexplained reason I rarely see the incipient case, only rarely does a carcinoma amenable to thyrotomy present itself."

Beck and Guttman<sup>12</sup> remark, "The largest number seen were extrinsic" In any case the relative incidence of the disease in the larynx and laryngopharynx in India is a point for further observation.

### ETIOLOGY

The essential cause of the disease remains as obscure as that of carcinoma in general St Clair Thomson<sup>10</sup> concludes its discussion thus—"We are thus driven back upon the words of Bacon, 'The inquisition of Final Causes is barren and like a virgin consecrated to God produces nothing'"

Jackson<sup>14</sup> reduces the expression of the problem to the following formula—

$$A + S + C + I + F + a + T + H + XYZ = E.$$

in which A equals age, S, sex, C, senile changes, I, irritation, F, frustrated repair, a, alcohol, T, tobacco-smoke, H, heredity, XYZ, factors, the as-yet-undetermined and E, etiology The problem remains a formula because we cannot interpret XYZ According to the present conception the etiological factors may be divided into intrinsic and extrinsic.

**INTRINSIC Heredity**—There is first of all a general constitutional susceptibility to cancer There is also secondly a local susceptibility or "organ inferiority" which varies with age, sex and race

**Age**—Below is given in a tabular form the incidence of the disease according to age and sex

	Up to 20	21-30	31-40	41-50	51-60	61-70	71-80	Total
Female	1	5	12	3	2	0	0	23
Male	2	6	16	19	8	1	0	52
Total	3	11	28	22	10	1	0	75

In this series, 7 per cent of the females and 46 per cent of the males are under the age of 40 years and the maximum incidence is in the fourth decade in the female and the fifth in the male, whereas in U.S.A the maximum incidence is in the seventh decade<sup>10</sup> This is partly accounted for by the fact that 41 per cent of the cases in this series are of the post-cricoid area which has been observed to occur earlier than cancer elsewhere In this series there is a female and a male of 20 years both presenting an epithelioma of the post-cricoid area histologically confirmed If age and senile changes in epithelium are factors in its causation, it is possible that cancer manifests at an earlier age in the Indian people who have a shorter expectation of life.

**Sex**—The site of the disease is shown below as manifested itself in each sex in this series

Site	Male	Female	Total
I Intrinsic	10	2	12
II Extrinsic, excluding post-cricoid	27	5	32
III Post-cricoid	15	16	31
Total	52	23	75

Excluding post-cricoid area, extrinsic as well as intrinsic disease is five times more common in the male than in the female. The disparity of incidence in the sexes is not so great as in the statistics of the West, but it is still very marked. It has been said that as women susceptible to cancer develop it in the uterus or breast its incidence in other organs common to both sexes remains low in women as compared to men While this explanation appears to be satisfactory as far as it goes, Chevalier Jackson<sup>14</sup> doubts if it can explain also the extreme disproportion of man getting affected in the larynx twelve times more frequently than woman. Equally puzzling has been the observation of Logan Turner<sup>17</sup> that carcinoma in the post-cricoid area is seven times more frequent in women than in men. An explanation for this startling disparity was looked for in the operation of the extrinsic factors It is difficult to say whether tea drinking or use of hot fluids irritating this region have anything to do with it There is also a parallel instance to this, of the preponderance of high oesophageal cancer in men in China where they eat hot rice. As regards this domestic custom there is no difference between China and India It looks as if there is some causal relationship between taking hot irritant drinks and foods and the post-cricoid cancer, for in this series 50 per cent of the extrinsic cases are of the post-cricoid area and the number is about equally divided between the sexes, men 15 and women 16 This needs further study

Hormonal stimulation is another factor which is under investigation<sup>18</sup>

**EXTRINSIC**—The presence merely of general constitutional susceptibility and a constitutional "organ inferiority" are not enough to start the neoplastic process The operation of a third factor, an extrinsic factor such as chronic irritation, trauma, viruses, parasites, etc., is essential The extrinsic factors have been again classified into<sup>19</sup>

1. factors which cause the primary carcinomatous bias,
2. those which enable the biased cells to manifest their carcinogenic capacities

In tar, a chronic irritant, the two factors are combined but not always closely associated Of all the known extrinsic factors, chronic irritation is the most important so far as the present subject goes Mention must be made of some of its sources such as alcohol, tobacco, dust and vocal abuse, but precise data are not available with regard to the actual number exposed to the effects in this series It must be pointed out, however, that a large number of the poorer class of patients of both sexes in the area of Vizagapatam are inveterate smokers Leukoplakia and cancer of the hard palate are very much more common in women who smoke with the lighted end of the cigar inside the mouth evidently to escape notice and the social stigma attached to smoking amongst women As regards the carcinogenic properties of tobacco smoking the experiments of Flory<sup>20</sup> would appear to have given almost conclusive proof.

Plummer-Vincent syndrome has, of late, been fairly frequently met with as reported before by me<sup>21</sup>. It is a possible precancerous condition.

#### PATHOLOGY

It is now established that endolaryngeal cancer is met with most commonly on the vocal cord. The central or anterior half of the cord is the favourite location. The two extremities in the usual chordal cancer are generally quite free in early cases.

According to St. Clair Thomson<sup>22</sup> the subglottic area is the next favourite location and it is rare in the ventricular band or in the sinus of Morgagni and almost unknown in the interarytenoid region. According to Jackson,<sup>23</sup> 85 per cent originate in the vocal cords. Next to the cords, the ventricular band including the ventricle is most frequently affected and then the interarytenoid region. In a small percentage, he says, the growth originated in the anterior wall of the larynx above and below the cordal level. This is a very rare site as compared to the cordal commissure. A small early squamous-celled carcinoma located at the edge of the vocal cord and extending along the edge. There is less tendency to extend downward into the subglottic region and still less tendency to extend outward into the ventricle.

The site or origin of disease in the cases presented in this series, so far as could be ascertained from clinical examination, is as follows —

Sex	V.C.	V.B.	Subglottic	Undetermined	Total
Male	2	1	2	5	10
Female	0	0	0	2	2
Total	2	1	2	7	12

One of the subglottic growths was verified post mortem, as secondary to a malignant thyroid tumour.

The site of origin in the laryngopharyngeal growths in this series is as follows —

Sex	Posterioroid	Pyramidal fossa	Epiglottis	Undetermined	Total
Male	15	6	3	18	42
Female	16	1	0	4	21
Total	31	7	3	22	63

Of the total number of 23 women the posterioroid growth accounted for 16 or 70 per cent. The posterioroid area has thus not only justified the notorious frequency that it has already been credited with in the female but has even enhanced it by claiming 15 males out of 52 i.e., 29 per cent. This point was reported by me already.<sup>24</sup> It is contrary to English and American experience. According to them, the posterioroid area is the least commonly attacked in men. It, therefore, awaits further verification in India.

Of the 63 cases in which the growth was classified as extrinsic, 6 appeared to be originally intrinsic as already stated.

Histology—Jackson<sup>25</sup> says "Squamous-celled carcinoma constitutes 98 per cent of the malignant growths of the larynx."

Malignant disease of the larynx was also encountered in twelve other forms by him as follows —

- 1 Basal-celled carcinoma (basalioma, cylindroma, perithelioma)
- 2 Glandular-celled carcinoma
- 3 Cystic adenocarcinoma
- 4 Endothelioma
- 5 Sarcoma
- 6 Myxosarcoma
- 7 Malignant lymphoma
- 8 Malignant osteoma
- 9 Osteosarcoma
- 10 An aggressive type of chondroma
- 11 Malignant angioma
- 12 Leiomyoma

Positive histological reports were obtained in 18 cases of the laryngopharynx and 5 cases of the endolaryngeal disease, all excepting 1 obtained from biopsy specimens.

The results are as follows —

#### Intrinsic —

- |  |   |
|--|---|
| 1 Squamous-celled epithelioma                  | 3 |
| 2 Malignant papilloma                          | 1 |
| 3 Secondary to malignant tumour of the thyroid | 1 |

A subglottic isolated growth—specimen obtained post-mortem

#### Extrinsic —

- |  |    |
|--|----|
| 1 Squamous-celled epithelioma                        | 15 |
| 2 Epithelioma, suggestive of origin from a papilloma | 1  |
| 3 Carcinoma of branchiogenic origin                  | 2  |

#### SYMPTOMS AND SIGNS

Hoarseness or change in the voice is the earliest and the most common symptom in laryngeal diseases. It was the first symptom in all cases in this series excepting in the one with secondary subglottic growth. Fixation of vocal cords was noted in six and limitation of its movement in 3 out of the 12 cases. Arytenoid was found fixed in 1 case.

The following table gives an analysis of other symptoms present on admission —

TABLE SHOWING ANALYSIS OF SYMPTOMS

Symptoms	No Cases
Complete aphonia	1 (8%)
Dysphagia	5 (42%)
Pain shooting into the ear	2 (16%)
Cough	3 (25%)
Dyspnoea	3 (25%)
Stridor	2 (16%)
Salivation	1 (8%)
Enlarged cervical glands	1 (8%)
Thyroid enlargement (primary)	1 (8%)

The symptoms of disease of the laryngopharynx are primarily pharyngeal in marked contrast to the above. Dysphagia was the chief symptom that forced the large majority of patients to seek admission into the hospital.

The following table is an analysis of the other symptoms noted on admission —

Symptoms	No Cases
Pain in swallowing radiating to ear	30 (48%)
Marked swelling of glands	21 (33%)
Salivation	18 (29%)
Hoarseness of voice	14 (22%)
External tenderness & swelling over larynx	9 (14%)
Fixation of vocal cords	8 (13%)
Cough	6 (9%)
Hæmoptysis	5 (8%)

## DIAGNOSIS

\* Jackson<sup>23</sup> gives the following list of diagnostic possibilities

Syphilis, tuberculosis including lupus, scleroma, eversion of the ventricle or prolapse of the sacculus, blastomycosis and other mycoses, keratosis, pachydermia, perichondritis, benign growths including granulomas and acromegaly, hæmatoma, contact ulcer, recurrent paralysis, crico-arytenoid arthritis and other inflammatory conditions and leukoplakia and other precancerous conditions

In the last stages when the majority of cases of the laryngopharyngeal disease were admitted, the characteristic appearances of the growth and the elimination of other causes of chronic ulceration chiefly tuberculosis and syphilis leave hardly any doubt as to the diagnosis. Biopsy was, however, felt very often necessary to establish the diagnosis in the post-cricoid and endolaryngeal disease and it was resorted to whenever it was possible. Microscope is by no means infallible but it reveals, when positive, the degree of malignancy in accordance with Broder's classification. It is helpful in prognosis and in the choice of the most appropriate method of treatment. Jackson says, 'It is always an early and an indispensable step. But I wish to record here that biopsy breaking through, as it does, the epithelial barrier in a septic canal like the hypopharynx does not appear to be absolutely safe. A Hindu male aged 35 years in good general health developed cellulitis of the neck and died of septicæmia after the removal of a small piece from the hypopharynx.'

In two patients where a biopsy on the primary growth had been unsuccessful, secondary deposits were histologically identified in the cervical glands after dissection and in the lungs radiologically in one patient. It is noteworthy in 9 out of 12 cases of endolaryngeal disease the blood Wassermann was negative i.e., in 75 per cent. In the 63 cases of disease of the laryngopharynx blood Wassermann was strongly positive in seven and weakly positive in eight cases, i.e., 25 per cent. Tuberculosis was not found associated in any of the cases in the series.

## PROGNOSIS

The mortality of the untreated cancer of the larynx and laryngopharynx is 100 per cent. The expectancy is between 1 to 2 years depending upon the site and pathology of the tumour. It is much shorter in the grades 3 and 4 and in tumours of laryngopharynx. The post-cricoid disease appears at an earlier age and progresses very rapidly. The prognosis in an early carcinoma of the vocal cord is very good if operated, without any but the usual risks of the operation. It confers a lasting cure of 80 per cent and even higher while retaining a useful voice. Cordal carcinoma offers another advantage giving rise to hoarseness very early but this warning symptom is seldom taken heed of in time, for hoarseness is a common and frequent symptom of ailments, from which recovery is the rule. Hence the dictum of Jackson<sup>23</sup>, "every case of hoarseness in an adult should be regarded as cancerous until it is otherwise proved by every diagnostic means we possess."

## TREATMENT—CURATIVE

Treatment is curative and palliative.

The accepted methods of curative treatment are surgery, irradiation and a combination of both. Since Billroth did his first laryngectomy in 1873 great strides have been made in the surgical treatment of laryngeal carcinoma. In no other region of the body the chances of permanent cure of cancer by

surgery are more helpful than in the endolaryngeal. With regard to laryngopharynx itself the position of surgical treatment has been rather very disappointing though in the hands of eminent surgeons brilliant results have been no doubt obtained by heroic operations like lateral pharyngotomy and pharyngolaryngectomy. The trend of opinion is distinctly in favour of irradiation. Jackson<sup>23</sup> puts it as follows "The tip of the epiglottis is the only part of the extrinsic area amenable to operation." Broadly speaking the treatment of intrinsic laryngeal carcinoma is primarily surgical and that of the extrinsic or laryngopharyngeal is one for irradiation.

In the case of early localised growths of larynx irradiation is probably as effective as surgery and it is a matter for preference for the individual patient and doctor but generally speaking operative removal is the treatment of choice. In the late cases in inoperable stage there is no other treatment than irradiation. In between the above two categories there are bound to be a number of cases where it may be most difficult to arrive at a decision.

On the strength of Broder's classification based upon histological differentiation of cells, carcinomata are spoken of as radiosensitive and radioresistant but this grouping is no longer considered as of absolute value. Harris and Klemperer<sup>24</sup> have indeed recently said that there are no pathological criteria except possibly for the number of mitoses which permit of such differentiation thus almost contradicting the hitherto accepted belief. Cutler<sup>25</sup> points out further that radiosensitivity is not the same thing as radiocurability while the former may be predicted with reasonable certainty on the basis of microscopic structure, the latter is dependent upon the site, the extent and the mobility of the lesion and the surrounding structures and the invasion and fixation of the lymphatic glands. High grade tumours respond quickly to irradiation but not necessarily any better. Above all as Chevalier Jackson<sup>26</sup> lays considerable stress upon, the general condition of the patient is a great deciding factor. A patient organically sound with a good vascular system is certainly a great asset and goes in favour of surgery. There is no doubt that supreme care and judgment are to be exercised in the choice of treatment most suitable for each individual case.

## I. SURGERY

1. *Endoscopic removal*—This is possible in the case of epiglottic tumours but it is not advisable unless it is an extremely limited lesion at the tip.

• *Intralaryngeal excision* for cordal disease is also not advisable as it exposes the patient to unjustifiable risks.

2. *Laryngofissure*—This is the method of choice where the growth is small and limited to the middle of the vocal cord whatever be the estimate of its malignancy by the histological examination. Extension and involvement of the anterior commissure and even of the opposite cord is not a contraindication, as its excision can be effected by Jackson's anterior commissure technique. "Involvement of the entire length of the cord that does not extend far downwards into the subglottic region and does not impair the mobility of the corresponding crico-arytenoid joint is also no contraindication."<sup>27</sup> Depending upon the extension of the disease, portions of the thyroid, cricoid or arytenoid cartilages are excised. A sort of hemilaryngectomy is thus done as suitable for each individual case instead of a formal old fashioned hemilaryngectomy which has now been abandoned. Diathermic coagulation may be resorted to in case the line of section falls close to the infiltrated tissue. Gordon B New<sup>28</sup>

very often employs this to destroy the base after excision of the tumour

3 *Laryngectomy*—This is indicated in cases in which the growth involves the entire length of the cord with involvement of the arytenoid region or extended to the aryepiglottic fold. Laryngectomy is recommended by Jackson<sup>22</sup> in those cases only when the grade of malignancy is 1 or 2. If the grade is 3 or 4, irradiation is preferable. Laryngectomy has thus become the treatment of choice in laryngeal cancer which is unsuitable for laryngofissure but still endolaryngeal

4 *Subhyoid pharyngotomy*—According to Lionel Colledge<sup>23</sup> it is applicable to carcinoma of the epiglottis. Jackson<sup>27</sup> points out that nowhere in the body is there a greater contrast between early and late stages of disease than in the epiglottis. If it is confined to the tip it is a strictly local process but if it has extended or started downwards it is the most fatal of all diseases because of the leakage into the base of the tongue. Radiation then is the only treatment

5 *Transhyoid lateral pharyngotomy (Trotter's) combined with subsequent plastic operation*—For early growths of the epiglottis, the aryepiglottic fold and the postercoid area

6 *Pharyngolaryngectomy*—This is for the above tumours in a more advanced stage and for the tumours of fossa pyriformis and it includes a clearance of the glands on at least one side of the neck, removal of the whole larynx and either a partial or complete segment of the pharynx. A somewhat elaborate plastic operation is required at a later stage to reconstruct the pharynx, the patient being left with a laryngectomy

## II IRRADIATION

This includes treatment by x-rays as well as radium and it has two main purposes, curative and palliative. With regard to the former, Coutard<sup>24</sup> says, "Cancers composed of undifferentiated cells are treated successfully and easily by x-rays. Because of their tendency to dissemination, they are not biologically operable even though they are technically cancers composed of differentiated cells and are in the domain of surgery and usually are not curable by radiation because of the intimate connection between muscle and carcinoma cells." Irradiation has a large field of application as a palliative measure of treatment

1 *Deep X-ray Therapy*—Great hopes are centred on Coutard's new method—"protracted fractional technic." Hayes E. Martin<sup>25</sup> recently recommends a combination of radium and röntgen ray for the best results in certain cases

Jackson<sup>26</sup> says, "Good results have been obtained by irradiation" with this method. St. Clair Thomson<sup>28</sup> says, "It has promise of progress"

2. *Treatment by Radium*—(a) Radium beam therapy<sup>29</sup>—It has most of the advantages of the deep x-ray therapy. There is no surgical interference necessary and there is no discomfort arising from the insertion of needles inside. Deep x-rays are most satisfactory than the beam method as they can be applied at a greater distance from the skin and for shorter time doses than with the present small amounts of radium.

(b) *Interstitial radiation with radium needles or radon seeds*. Better results are obtained with needles than with radon seeds. The dosage of the latter is uncertain and not uniform as in the case of the former. Tumours of the laryngopharynx are unsuitable for the use of this method

Radon seeds may be implanted in the larynx in the growth itself or very close to it

*Finzi-Harmer Method*—With regard to this method Holt Diggle<sup>30</sup> points out that compared with laryngofissure this shows more risk of recurrence, often with more prolonged and tedious convalescence and he finds that voice is not quite so good as after a fissure.

(c) *Radium Plaques*—This is a method of external radiation attempted with a small quantity of radium in the absence of beam therapy. This is combined with interstitial radiation whenever possible. By whatever method irradiation is chosen to be given the full carcinocidal dose must be given at the first treatment, for irradiation renders a growth more resistant and the normal tissues more sensitive to the rays on a second occasion.

## III COMBINATION OF SURGERY WITH IRRADIATION

Irradiation has its use in combination with surgery. It destroys the young and active cells of the growth and renders an adherent growth more movable

"In the management of carcinomas composed of undifferentiated cells, it is wise to precede the operation by a comparatively small dose of x-rays. The surgical operation should follow the irradiation by about 17 days after the first x-ray treatment. (3000 units in 10 to 15 days)"

In the management of differentiated carcinomas which infiltrate the muscles and which are inoperable without being too extensive, it is sometimes useful after a tracheotomy to perform an intentionally incomplete operation in order to conserve the greater portion of the larynx. The operation the aim of which is to remove the most radio-resistant part of the growth is followed as soon as possible by complete irradiation. This irradiation should be administered before there has been a chance for fibrosis to develop. During the time immediately after the operation there exists a type of post-operative cellular activity which renders the tumour cells more radio-sensitive. When the type of cancer which is composed of differentiated cells has destroyed muscles and cartilage, the operation serves to eliminate the infected and necrotic tissues. For the reasons which have been discussed, it is necessary that therapeutic procedures in both circumstances be grouped as closely as possible in order that the second treatment received the greatest benefit from the first."

## TREATMENT—PALLIATIVE

Unfortunately, the large majority of patients come too late for any hope of cure. Something has to be done to relieve the suffering of these unfortunates. Apart from the oral and other hygienic measures and tracheotomy and gastrostomy which one is forced to do as a last resort, irradiation itself offers some relief to most of them. They are enabled to live for a few months or even years in comparative comfort and freedom from suffering

Jackson<sup>31</sup> says, "Palliation implies a hopeless outlook yet we have seen a number of inoperable cases in which irradiation has arrested a very extensive disease for a period varying from two to four years and in some few instances results have been seemingly permanent. The patient should be given whatever consolation may be possible. In hopelessly far advanced cases, irradiation produces a fatal toxæmia, in patients of better general condition irradiation is justifiable.

## RESULTS OF TREATMENT

The above are some of the most important of the present methods of treatment. Now what was done for the cases in this series and its results are given in the following table—

TABLE SHOWING THE RESULTS OF TREATMENT IN THE 75 CASES REVIEWED

S No	Nature of treatment given	Number relieved	Number discharged otherwise	Number dead	Remarks
1	Lateral pharyngotomy	—	—	1	
2	Radium & laryngofissure	1	—	—	
3	Interstitial implantation and external plaque application	4	—	—	
4	External plaque application	15	5	1	Only 2 of the patients were completely relieved of their symptoms and local signs all disappeared before being discharged
5	Tracheotomy and external plaque application	5	—	—	
6	Emergency tracheotomy	—	—	7	
7	Tracheotomy, gastrostomy and radium plaque.	—	—	2	
8	Implantation of radium	—	—	1	Sudden collapse after implantation of needles under local novocaine infiltration
9		—	—	1	
10		—	—	2	
11		—	—	1	Sudden hæmorrhage.
12		—	22	—	Cellulitis and septicæmia after biopsy
13		—	—	2	Discharged at their own request
14		—	4	—	Admitted moribund.
15		—	—	1	Absconded.
					Sudden heart failure
Total		25	31	19	

The above results present no doubt a very dismal picture but it could not be helped firstly because the majority of the patients were either admitted too late for any curative treatment or their general condition altogether precluded its consideration or they refused it

Secondly, with regard to irradiation, the available facilities are very limited. There is no deep x-ray plant Till two years back we had a small quantity of radium. Radiation was given as a rule by means of plaques Interstitial implantation was resorted to whenever possible Of the twelve laryngeal cases two only were considered suitable for laryngofissure and both were admitted after our radium left us Both refused operation One of them absconded and was no more heard of The second returned after six months with a huge mass over the neck about to break down and fungate and with dysphagia Histologically it was placed in grade III

Of the other ten, one was a patient with a subglottic tumour detected endoscopically, cords were uninvolved. There was thyroid enlargement and he died suddenly of heart failure

Another patient was admitted with severe dysphagia and stridor An emergency tracheotomy had to be done on the fourth day of admission. Laryngoscopic examination showed an ulcer with everted margins involving the right epiglottic fold and the ventricular band. Right vocal cord was definitely limited in movement Left vocal cord showed congestion. Three radium needles (3 mgm each) were implanted and a dose of 1285 mgm hours was given with considerable regression in the local appearances of the growth and the ulcer appeared to have healed But the vocal cord still appeared diseased. Six weeks later a laryngofissure was done, the thyroid ala and the mass were excised Patient's condition was very good at the time of discharge. Tracheotomy opening was closed He was able to breathe normally and he had a weak hoarse voice Neither the biopsy specimen taken before treatment nor the tumour tissue removed by the later operation showed definite evidence of malignancy W R. was negative. Concentration test for tuberculosis bacilli was negative Lungs were very clear radio-

logically At my request, the patient came up to see me, just a few days back four years after discharge from the hospital He is in excellent health. The larynx shows no recurrence, of the tumour and quite a wide glottis is seen He said his voice improved very much during the last six months

One patient came in with cervical glandular metastasis fixed to deeper structures, right vocal cord fixed She was treated with a radium mould and discharged relieved. She, as well as seven other patients where laryngectomy was indicated did not consent for operation and were discharged otherwise.

Of the 63 cases of laryngopharyngeal carcinoma, in only one, a female aged 40 years with a postericoid growth was a lateral transthyroid pharyngotomy done. She was convalescing and in fairly good condition One month after the operation she appeared to have pulled out one night in a fit of mental depression both the stomach tube and the tracheotomy tube unnoticed by the night nurse and expired.

Most of these cases were admitted in the hospital in an advanced stage of the disease and the treatment could only be palliative. In two patients of the 24 showed as relieved after radium treatment, there was complete relief from all symptoms and signs as reported before by me 21 patients were discharged otherwise and 18 died in the hospital

It must be confessed that from the point of view of permanent success there is little that has been achieved But nothing better could be expected under the existing circumstances For even in well equipped western institutions for radiotherapy, the patients having arrived late, the results obtained are merely palliative in the large majority of them. J Holt Diggles of the Manchester Radium Institute records that out of 126 extrinsic and intrinsic cases only three survived 12 months And of Stebbing's 306 patients in Lambeth Hospital 20 were alive at the end of 3 years

When we had the small quantity of radium, it was a consolation to be of some little help to these unfortunate patients and we await its return and still better facilities in the near future.

## SUMMARY AND CONCLUSIONS

- 1 The frequency and increase in the incidence of laryngeal carcinoma awaits investigation in India
- 2 The titles Cancer of the Larynx and the Cancer of the Laryngopharynx are preferred to the terms Extrinsic and Intrinsic Cancer of the Larynx
- 3 Notice is taken of some of the known etiological factors, intrinsic and extrinsic.
- 4 The high proportion of postcricoid cancer in men in this series reminds one of the Chinese analogy already recorded.
- 5 The possibility of cancer occurring at an early age in Indians is suggested.
- 6 The pathology, symptomatology, diagnosis and prognosis are briefly considered.
- 7 The several accepted lines of treatment are described. Mention is made of the treatment adopted in this series of cases and its results
- 8 The results are disappointing at present. But the future is hopeful with earlier diagnosis and provision of adequate facilities of treatment.
- 9 It is most important that a concentrated and coordinated effort is made to tackle the cancer problem in India

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(Continued from page 8)

In non endemic areas cases with irregular fever, enlarged liver and spleen and positive (+++) aldehyde test should not be diagnosed as kala azar unless the parasite is demonstrated either in the peripheral blood, bone marrow, liver or spleen. Some of these cases respond to pentavalent antimony. A negative aldehyde test is much more significant in a suspected case with spleen reaching the level of the umbilicus and it might be used to eliminate kala-azar.

Indigenous cases have been reported from other non-endemic areas in India viz., the West Coast (Mudaliar *et al*, 1926), Dera Ismail Khan (Horse, 1924) and Malabar or Coimbatore (Shortt and Swaminath, 1937)

How do patients in these non-endemic areas get infected? Swaminath *et al* (1942) succeeded in transmitting kala-azar to all the five (100 per cent) human volunteers by the bite of infected sand flies (*Phlebotomus argentipes*). The other alternative method of transmission is by the oral route. Leishmania were isolated from the faeces (Shortt *et al*, 1929), from the urine (Shortt, 1923) and from the nasal smear (Shortt

*et al*, 1937). Hamsters were infected by oral and conjunctival routes (Shortt *et al*, 1928-29)

In all probability the mode of infection in these indigenous cases in non-endemic areas is by the oral route

## CONCLUSIONS

1 Two indigenous cases of kala-azar are reported from Vizagapatam district, a place previously supposed to be free from the disease.

2 Fallacies in the diagnosis of kala-azar in non-endemic areas and the probable method of transmission in these cases are discussed.

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## KALA AZAR IN NON ENDEMIC AREAS

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During the years 1933-42, twelve cases of kala-azar were admitted in the King George Hospital, Vizagapatam. All the cases except two were imported either from Madras, Calcutta or some other endemic area. Short notes of the two indigenous cases are given below —

**Case 1**—K. V. Hindu male, aged 35 years, a native of Yelamanchili (Vizagapatam district) was admitted into the hospital on 30-7-35 for abdominal pain and frequent stools with blood and mucus. The patient was a thin emaciated individual, slightly anæmic, no jaundice, spleen palpable 2 fingers below the costal margin, liver just palpable below the costal margin. No masses were felt in the abdomen. Respiratory and circulatory systems normal. Blood smear showed leucopenia, anisocytosis, and poikilocytosis (microcytic anæmia) but no parasites. Motions showed polymorphonuclear leucocytes, R.B.C., macrophage cells and columnar epithelial cells. The condition was provisionally diagnosed as tubercular enteritis. The patient gradually improved but used to get occasional attacks of fever. Repeated blood examinations revealed no parasites but showed only leucopenia. He was put on a liberal diet. The general condition of the patient improved but on 30th August, he got an attack of fever varying from 102° to 103°F which lasted for a week. In spite of the patient being put on quinine, cod liver oil and syrup ferri iodide, he did not improve and was running a low fever. On 22-11-35 the spleen was palpable 4 fingers below the costal margin. He was again put on quinine with no response, and on 6-12-35 an aldehyde test was done which was strongly positive. On 8-12-35 a liver puncture smear showed Leishman Donovan bodies. He was treated with injections of urea stibamine and was discharged cured on 3-3-36.

**Case 2**—C. Hindu male, aged 35 years, a native of Vizagapatam district was admitted on 26-3-39 with a history of irregular fever of two months duration. Physical examination showed a poorly nourished individual with slight anæmia and hæmolytic jaundice. Abdomen slightly distended with free fluid in the peritoneal cavity. Spleen and liver enlarged. Heart showed hæmic murmur in the pulmonary area, otherwise normal. Other systems normal. Blood smear showed microcytic anæmia. Van Den Bergh—indirect positive. Urine normal. Motion showed ankylostoma ova. He was running a temperature between 100° and 101°F. The aldehyde test was strongly positive. Since the patient's general condition was very bad spleen puncture was not done and no parasite could be demonstrated in the peripheral blood. A course of urea stibamine injections reduced the size of the spleen but the temperature began to rise. The patient gradually grew worse and finally died on 28-6-39. Post mortem showed miliary tuberculosis of the peritoneum, meninges etc., and enlarged liver and spleen. Smear from the spleen showed L.D. bodies.

The first patient is a native of Yelamanchili (Vizagapatam district) about 40 miles from Vizagapatam. He has never gone outside the district, never had a history of fever before his admission into the hospital and the spleen was palpable only two fingers breadth below the costal margin. Till 1935 indigenous kala-azar has not been observed in Vizagapatam. The second patient was seen in 1939 and a clinical diagnosis

of tuberculosis and kala-azar was made. He was treated with injections of urea stibamine. The diagnosis was confirmed by finding the L.D. bodies in spleen smear post-mortem. This patient too has not gone outside the district although in the district itself he was moving from place to place. Treatment with antimony reduced the size of the spleen but fever and abdominal distension continued showing that tuberculous condition had flared up. Napier (1937) reported two similar cases of pulmonary tuberculosis and kala-azar both of whom died within a few months after discharge from the hospital. Both the cases quoted above are indigenous cases of kala-azar occurring in Vizagapatam district previously supposed to be free from the disease.

A similar investigation conducted in Guntur from 1929-32 showed that kala-azar was not present there, either indigenous or imported. Cases with irregular fever with enlargement of the spleen and liver were admitted and spleen punctures were done on 20 patients with negative results. In two of these cases aldehyde test was strongly positive and spleen punctures on three successive occasions were negative for L.D. bodies.

### DIAGNOSIS

Diagnosis of kala-azar is made by finding the parasite in the peripheral blood, or bone marrow, liver or spleen puncture smear. In endemic areas a history of irregular fever with enlarged liver and spleen not amenable to quinine and positive aldehyde test can be taken as diagnostic of kala-azar. Cases with similar clinical picture were seen both in Guntur and Vizagapatam and repeated spleen punctures did not reveal any L.D. bodies.

Aldehyde test was done in two hundred cases from a mixed general hospital population in Guntur. The technique was the same as that employed by Napier (1928) with a very slight difference of change of time from 20 to 30 minutes for the strongly positive reaction. The results are given below.

A Strongly positive reaction (+++) was observed in 8 cases as analysed below.

- |   |   |
|---|---|
| 1 Enlarged spleen and liver with a history of irregular fever, spleen puncture negative for L.D. bodies on 3 occasions at intervals of a week | 1 |
| 2 Secondary syphilis with low fever and spleen palpable 2 fingers below the costal margin   | 2 |
| 3 Cold abscess with fever and spleen enlarged to 1 finger below the costal margin   | 1 |
| 4 Advanced mycetoma of the foot   | 1 |
| 5 Atrophic cirrhosis of the liver   | 1 |
| 6 Carcinoma of the rectum   | 1 |

B Moderately positive (++) reaction was observed in 7 per cent of the cases. One of these simulated kala-azar but repeated spleen punctures were negative for L.D. bodies.

C Slightly positive (+) reaction was observed in 8.5 per cent of the cases. One was suggestive of kala-azar but spleen puncture was negative.

Thirty-nine cases (19.5 per cent) taken at random from a mixed population suffering from various diseases showed a positive reaction out of which 4 per cent were strongly positive. The question of diagnosis of kala-azar arose in three of these cases. Three similar cases were observed in Vizagapatam also in which aldehyde test was strongly positive and spleen puncture did not reveal L.D. bodies in any of them.

(Continued at foot of page 7)

## Arsenical Preparations in the TREATMENT OF SYPHILIS

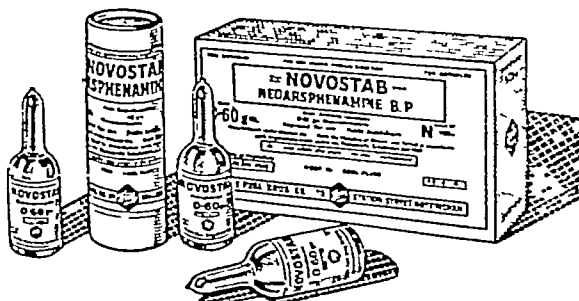
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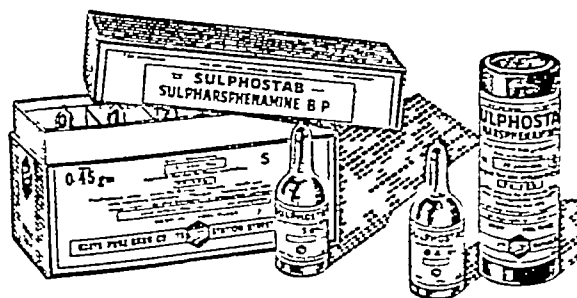
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## SOME SPEECH DEFECTS AND THEIR REMEDIES

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**Stuttering**—Stuttering is a defect of the rhythm of speech characterized by blocking of speech or by a compulsive repetition of certain sounds. Recently, it has been found that there are more male stutterers than female stutterers, the ratio being about 5 to 1. Stuttering may begin in three periods of life, at the onset of speech, from ages 5 to 7, and at adolescence. Stuttering is intermittent. Stutterers can talk to themselves when alone, can sing well without hesitation on words and more often consider themselves nervous. They are often in a state of excitement, more often feel self-conscious in the presence of superiors in the academic or business world. They are frequently troubled with feelings of inferiority and lack of self-confidence, they also blush very often. They find it difficult to speak in public. They express themselves better in writing than in speaking. They are slower in making decisions. Anxiety, fears, inferiority feelings, introversion, neurosis, self-consciousness, shyness are other traits.

**Types of stuttering**—Some stutterers imitate vomiting actions while attempting to speak, others have masticating movements, some tongue-sucking activities, yet others grimace or make a combination of uncontrollable activities. Some of the severe stutterers have spasms of speech whilst others have predominantly clonic spasms. The former groups are timid, retiring, quiet, proud, sensitive, the latter are careless, unstable, vain, talkative and distractible. Sympathetic persons are likely to remind the stutterer of his speaking disability through their 'kindly' attitudes. Then again with the advent of adolescence, stutterers have been found to be not so attractive socially to the opposite sex as are non-stutterers.

Most of the other speech defects are rather prevalent in mental defectives—in only a third of such cases is normal speech present. It is not improbable that a speech defect with its attendant effect on the patient's peace of mind and with the usual ridicule by playmates or associates may be a determining factor in the etiology of behaviour problem. Correction of the defect may tip the balance from misbehaviour to behaviour so that adjustment of the patient at home may again be possible. The chief points to be considered in selection of patients for treatment are: The intelligence quotient ( $= \text{Mental age} - \text{Chronological age} \times 100$ ) should not be below that of the feeble-minded grade, mental age should be 5-6 years at least, the defect should not physically be too severe and in addition parole should be probable for the patient chosen. A kindly sympathetic attitude will help in gaining the confidence of the patient. Patience is extremely important, tact and understanding attitude necessary. Each patient should be treated as an individual problem. Prior to treatment the patient should be examined physically and mentally. Some organic defects such as tongue-tie corrected surgically, missing teeth replaced. Cleft palate does not lend readily to treatment. Re-education in the use of the tongue, muscles of the mouth throat and adjacent structures is necessary.

**Listening**—The child is taught tongue gymnastics and he must practise a short time each day—*sah, say, see, sa-c, soh, soo, ah, av, es, a is, oh, oo, sahs, says, sees, saus, sohs, soos*. It is good practice to have the child place his forefinger in front of his teeth and produce a hissing sound so that he can feel the breath on his finger. Constant repetition is essential imitating the correction and by using a mirror to see his own tongue in action. In stammering and stuttering

suggestion is the greatest principle of correction. An attempt should also be made to find out psychic conflicts. The patient must be reassured and urged to forget that he is a stammerer. He should first read to himself silently for reassurance and then read aloud in front of a mirror to experience a new auditory sensation.

**Dysphasia**—It is worth while discussing a few points about neuropathic speech disorders. Recently it has been asserted that dysphasia is a more accurate term than aphasia because the patients are usually not completely mute. Dysphasia is characterized by inability to express, comprehend or formulate speech giving rise to expressive dysphasia, receptive dysphasia and amnesic dysphasia.

In a case of dysphasia the examination is carried out according to the following plan—(1) A verbatim stenographic record of spontaneous speech is taken. (2) Naming objects and colours. (3) Following directions (point to your nose). (4) Reading aloud. (5) Comprehension in reading. (6) Repeating phrases after the clinician. (7) Taking dictation. (8) Performing simple addition and subtraction mentally and in writing. (9) Analogies which call up specific words (navy is to sailor as army is to what). (10) Sentence completion. (11) Absurdities (deciding what is foolish about a statement). (12) Completing missing parts of drawings. (13) According to degrees of spastic complications performance tests are used.

Expressive dysphasia comprises 50 per cent cases. It is characterized by scant speech which appears difficult, hesitant, mispronounced and there are repetitions. Here speech should be practised before the mirror since visual reinforcement is indicated. Writing and copying while pronouncing aloud is a good drill because it associates speaking, writing and spelling. Attention is paid more to verbs, nouns, adverbs and later adjectives (not so much to prepositions and conjunctions). The predominant disability in expressive dysphasia is concerned with intonation. So this type of dysphasia is the most disabling.

Receptive dysphasia is the traditional sensory type. Because of agnosia, apraxia, neologism, misapprehension, the patient's understanding cannot be judged from his actions or speech. His speech is rapid, explosive, confused and defective in diction. To begin with, the patient's auditory apparatus is stimulated, the patient repeats what the clinician speaks from behind. In this process he can hear what he can articulate and he cannot hear that which he cannot articulate.

Amnesic dysphasia is a defect only of words. There is no trouble with articulation or understanding but the fluency is fragmentary. As many mnemonic devices are used as possible and during treatment as many sense doors employed as possible.

Dysarthria is another variety of speech disturbance of which there are several types which are as follows: (a) Spastic type in which speech is dragging, indistinct, requires great effort and is accompanied by bodily and facial distortions. (b) Choreatic type characterized by extreme slowing down of articulatory movements. (c) Scanning speech in which we find excessive division of syllables and long pauses. The object of treatment is to establish the individual as a self-supporting normal personality in society. In all cases patients must be resigned to slow rates of speaking. Progressive relaxation of speech muscles is an important part of the treatment. (d) Bulbar type of dysarthria is characterized by flaccidity of the speech muscles. In this condition treatment exercises are concentrated on compensatory movements from the not affected side to mask weakness of the affected muscles. In all cases general physiotherapy gives the cue not to start speech training.

## PREVENTIVE MEDICINE

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If I were to write a book on Preventive Medicine I should make it a book of six chapters. The first chapter I would devote to the germ theory of infection, the second to immunology, the third to endocrinology, the fourth to nutrition, the fifth to heredity and the last chapter to social measures for the establishment of health centres for periodical medical examination, and the revision of medical curriculum for the training of the medical students in order that their course of instruction includes all the five sciences mentioned above on which preventive medicine is based. I propose to follow this sequence in this paper, as it is indicative of present day trends in the science of preventive medicine and I shall consider briefly the points under those headings which are likely to prove of the greatest interest to the medical practitioners.

### THE GERM THEORY OF INFECTION

As is well known all infectious diseases are caused by micro-organisms such as bacteria, protozoa and filtrable viruses and to be able to avoid infection, it is essential to know the sources of infection, the modes of spread of infection and the susceptible members in the family of the patient, for infectious diseases spread from the infected persons to other susceptible ones through known channels. It should be remembered that there are two sources of infection one is man and the other, the lower animals. Most communicable diseases such as typhoid, cholera, leprosy, malaria, small pox, yellow fever, syphilis, relapsing fever and tuberculosis have their focus of infection and origin in man, from the lower animals few communicable diseases have their origin, notably plague from rats, anthrax from cattle, Malta fever from goats, tuberculosis in part from cattle, and parasitic infestations from the eating of meat from the infected animals. It is very necessary to realise that ultimate sources of infection are infected human beings, or animals which may suffer from the infection and show signs and symptoms of the disease varying from the typical to the atypical cases which are not recognised clinically. These atypical and mild cases are active in the spread of infectious diseases. Such cases are met with in typhoid, plague, cholera, influenza and dysenteries. The medical practitioner should be on the look out for such cases in his out-patient dispensary and private practice, as those cases broadcast infection in a community. The other groups of infected persons who are reservoirs of infection are known as carriers. These persons carry the germs without showing any symptoms or signs of the diseases. Such carriers may be active in the spread of typhoid, cholera, malaria, hook worm, dysenteries and cerebrospinal fever. Carriers are classified as acute, chronic, temporary or permanent, convalescent, passive or active, or intermittent or incubatory. The carrier problem makes the control of infectious diseases difficult and complicated.

*Channels of Infection*—Infectious micro-organisms may enter the body through four channels which are specific namely by the mouth, through the skin, the nose and the genito-urinary tract. Of these the commonest entry is through the mouth. Hand is the vehicle of infection to this and other

channels. Therefore, the hygiene of the hand should be taught as first lesson in personal hygiene to pre-school and school children. I do not wish to go into the different modes of infection which are already known, such as insect-borne diseases, diseases spread through contaminated food, milk and water and through the air by droplet infection, such as tuberculosis, cerebrospinal fever, measles, diphtheria, influenza, common colds and whooping cough.

As regards the susceptible members of the family it is necessary to remember that children are most susceptible to many infectious diseases. Because of their age and lack of immunity, children are especially liable to tuberculosis and leprosy. The medical practitioners should, therefore, remember the children in the family of infected sick and endeavour to protect them by isolation and immunisation. In the control of infectious diseases the medical practitioner can help most by carrying out what is known as concurrent or bed-side disinfection of all excretions from the mouth and nose in the case of respiratory infection, such as diphtheria and tuberculosis, and from the bowels in the case of cholera, typhoid and dysentery and the discharge from eruptions or open lesions from the skin or mucous membranes and wounds, notably in such diseases as small-pox, leprosy, gonorrhoea and tetanus. It is worth while to remember that the seat of diseases influences the discharge of organisms, if any of the body surfaces is involved in the infectious process, the organisms are mingled with the secretions of the surfaces and are discharged with them. It cannot be too emphatically stated that if proper disinfection of the infective discharges is carried out efficiently at the bed-side, there is little danger of the spread of infection to the other members of the family or in the community.

The medical practitioner also can help in the control of infectious diseases by inoculating the contacts and other susceptible members of the family. Finally, he should remember to notify the medical officer of health promptly the occurrence of any infectious disease among his patients which is notifiable under the Municipal Act.

### IMMUNITY

Resistance to infection is the resultant of many factors, It depends upon immunity, natural, acquired or artificial, nutrition, heredity and other constitutional factors. Immunity in a restricted sense means the resistance of the body to a specific infection. It varies in different degrees, in different individuals and also at various times. There are different kinds of immunity known as natural or acquired, familial or racial, active or passive. From an immunological standpoint infectious diseases and recovery are phases of the struggle for existence between parasite and host. Infection is, therefore, a reaction in which the pathogenic powers of micro organisms on the one hand and the resistance of the individual on the other, are pitted against each other. The mechanism of immunity consists chiefly in the growth and multiplication and production of toxins by the infecting micro-organisms and the response of the body to these living or dead agents which stimulate phagocytosis and the production of antibodies. These circulate in the blood of an infected person. The body by this means destroys the micro organisms and neutralises the toxins produced by them. The medical practitioner should aid the body to be prepared in its struggle against infecting agents and reinforce the resisting powers of the individual to destroy the pathogenic organisms and to neutralise their toxins. This he may do by prophylactic inoculations against infectious

diseases, especially in the case of enteric infections, plague, cholera and small-pox. He should advise and inoculate all contacts who have been exposed to the risk of infection to any of these diseases, as a routine method, and also advise and inoculate persons proceeding on a journey to infected areas. Such inoculations confer immunity lasting for a few months to a year. Inoculations will have to be repeated every year, whenever there is a risk run by exposure to sources of infection. The factors that lower resistance are wet and cold, fatigue, insufficient food, lack of rest and sleep, worry, impure air and all sorts of excesses. The exact mechanisms involved by which immunity is lowered by the operation of these factors is not known but it is generally believed that they lower immunity in a special and not in a general sense.

*Exposure to wet and cold*—This probably acts as a depressant on the leucocytes and thus interferes with phagocytosis. The loss of immunity may result in the production of nasal catarrh or pneumonia or rheumatic infection depending on the nature of the infection present in the individual.

*Fatigue*—It is considered that katabolic products produced by muscular activity act injuriously on the cells of the tissues of the body and also on the leucocytes and antibodies. In this way it is thought fatigue lowers the resistance especially to meningococcus infection.

*Insufficient food*—It lowers immunity to certain infections but not to all infections. When food is unsuitable or taken in small quantities it is probable that a vitamin and mineral deficiency is caused which lowers the resistance to respiratory infections such as cold and tuberculosis.

*Exposure to impure air*—Impure air produces symptoms of oppression, headache, vertigo and vomiting due to heat stagnation. The physical factors concerned are temperature, moisture and movement of the air. Living in surroundings of impure air renders the susceptible to respiratory infections, such as cold and cough, pneumonia and tuberculosis.

*Insufficient sleep and rest*—When adequate sleep and rest are not given to the body, the nervous system becomes affected and the person becomes inattentive, bored and irritable and resistance to infection is lowered and the recovery period is prolonged.

Infectious diseases are pre-eminently the diseases of the first three decades of life. By forty a person has acquired immunity to many infections. The only infectious disease which shows an increased incidence with advancing years, is pneumonia. Between 35 and 55 a man stands on a firm foundation of health but after that age degenerative changes the result of previous damage due to infection and disturbances of endocrine balance manifest themselves as symptoms of old age.

#### THE SCIENCE OF HORMONES OR ENDOCRINOLOGY

Attainment of normal physical and mental maturity requires the normal functioning of the thyroid, the pituitary glands, the adrenals, the pancreas and the sex glands whose internal secretions are known as hormones or chemical regulators of the body. The various endocrine glands are interdependent and health depends on the action of secretions of one upon the other and their ability to co-operate in the regulation of physiological processes. Physiology of the body is upset if ductless glands secrete too much or too little; if it secretes too much a part or whole of the gland may have to be removed; if it secretes too little the deficiency has to be supplied either by feeding or by injections. The utilization

of the vitamins by the body in the process of metabolism is also controlled by the presence of suitable amount of glandular hormones. The science of nutrition and the science of endocrinology are thus inter-related.

The inter-relation of the ductless glands is seen in the adrenal cortex which secretes a substance which determines secondary sex characteristics through its control over the endocrine secretion of the sex glands. Recent work on hormones carried out at the Kaiser Wilhelm Institute at Berlin on the transition from androsterone to progesterone group, that is male to female sex hormone, and the correlation of androsterone with the corticosterone group of the adrenal cortex, clearly indicates how masculine traits are produced by the diseased adrenal cortex. It has also been established that the functioning of the thyroid and of the sex glands is controlled to some extent by the pituitary gland located at the base of the brain. The development of the secondary sex characteristics and the control of sex cycles in the females is seen to depend on the action of hormones. The pituitary gland is the most complicated chemical factory of all. Like the adrenals it is two glands in one. The anterior lobe produces three substances—one controls growth of bones, the second regulates the function of the ova in the female and maintenance of normal pregnancy, the third stimulates the ovaries and testes to grow and produce their own hormones which cause bodily and mental changes and puberty. It also acts on the thyroid glands. The posterior lobe produces minute quantities of several very active principles. The extract pituitrin contains all of them and raises blood pressure. It controls fat production and water content of the body. The discovery of ductless glands has opened a new field in preventive medicine and gives promise of curing the ill and prolonging human life. Bio-chemists in different laboratories of the world are actively carrying on research in isolating the hormones and also in artificially producing them for the use of medical practitioners. Many of these biochemical products are now available for the treatment of the patient who suffers from hormone deficiency. The basic difference between hormone and vitamin is that one is produced by the body itself and the other cannot be produced by the body but has to be supplied from outside sources. Both give rise to deficiency diseases with characteristic symptoms which may be cured or corrected by what is known as substitution therapy, as in the case of insulin therapy in the treatment of diabetes.

#### NUTRITION

The science of nutrition ranks in importance with that of endocrinology and forms one of the most important branches in preventive medicine. I will briefly touch on some of the important points in the newer knowledge of nutrition. Foods are at present classified on a physiological basis rather than on a chemical basis as follows.

1. Body-building foods which have to be provided for growth, repair and replacement through wear and tear. These are animal proteins which are found in meat, fish, poultry, and liver.

2. The energy-producing food stuffs are those which produce energy and heat required for living. These are carbohydrates and fats found in sugars, cereals, animal and vegetable fats, dry fruits, green vegetables, dried nuts and root vegetables.

3. Protective foods are known as vitamins or accessory food factors. These are essential in protecting the body against

diseases, and certain diseases are directly due to their lack in the diet. Diseases are easily resisted and overcome if the vitamin supply is adequate, they together with certain minerals are essential for normal growth and development and for the maintenance of health. These are found in milk and milk products, in leafy vegetables, fruits, fatty fish, eggs and glandular tissues. A balanced diet therefore should contain (i) the required amounts of calories, (ii) first class proteins (derived from animal sources), (iii) vitamins, (iv) mineral matter. In the case of small children, three fourths of the total number of calories should be derived from protective foods, in the case of adolescents, one half of total calories required should be derived from protective foods. In a balanced diet, the proteins derived from animal sources should form 30 per cent of all proteins. The important vitamins are vitamin A which increases resistance to infection, vitamin B necessary for the health of nerve tissues, skin and intestine, vitamin C prevents scurvy, vitamin D plays a part in the formation of bone and teeth, vitamin E affects fertility. The important minerals which are essential for the health of the body are Calcium and phosphorus found in milk and fish, iron, manganese and copper found in egg yolk, peas, spinach and raisins and iodine in small quantities essential for the proper functioning of the thyroid gland. The richest source of calcium is cheese, cow's milk, egg yolk and spinach. A good source of phosphorus is meat and also milk, cheese and eggs. Iron is present in liver in large quantities and also in eggs, oatmeal, dried fruits and raisins. Iodine is present in sea weeds and in variable quantities in vegetable products. The chief sources of vitamin A are dairy products, green and yellow fruits, vegetables, eggs, carrots, red palm-oil, cod liver oil and shark liver oil. Vitamin B<sub>1</sub> is found in yeast and wheat germs and vitamin B<sub>2</sub> in liver, yeast and green leafy vegetables while vitamin C is found in raw summer fruits, raw vegetables and citrus fruits and vitamin D in milk, butter, egg yolk, cod liver oil and other fish oils. Vitamin E is found chiefly in vegetable oils especially in wheat germs and green peas and pineapples.

*Mineral deficiencies and diseases* Women suffer from mineral deficiency diseases more frequently than men. A deficiency of calcium in the diet may be found antenatally and postnatally among pregnant and lactating women. Iron is frequently deficient in the diet of pregnant and lactating women. Women also lose a part of their supply of iron through menstruation. Iodine deficiency is noted in areas where endemic goitre is prevalent. Iodine, calcium and iron in sufficient quantities should be provided in the diet during pregnancy, childhood and puberty.

*Vitamin deficiencies and diseases*—Deficiency of vitamin A in diet causes skin lesions, xerophthalmia, bronchopneumonia, and stone in the kidney. Deficiency of vitamin B<sub>1</sub> causes beriberi, and of vitamin B<sub>2</sub>, cessation of growth, gastro-intestinal and nervous disorders and its absence is associated with pellagra. Vitamin C deficiency causes scurvy. Vitamin D makes available the calcium in the diet for the teeth and bone-formation, when this vitamin is deficient, it produces malformation of the bone, rickets, osteomalacia and tooth defects. Vitamin E deficiency may cause frequent abortions in women.

It must be noted that food deficiencies do not affect all persons alike, some are affected more than others. The problem of susceptibility to food deficiency requires further investigation. The quality and quantity of food consumed depend upon the economic status, religious and social prejudices

and habits of various communities in this country. It is, therefore, essential that the medical practitioners should take every opportunity in treating the sick to emphasise the importance of well balanced diet in the maintenance of health of the family. Malnutrition is commonly found among children and adolescents even in the families of well-to do persons, owing to superstitions and prejudices which govern their ideas regarding diet. Kitchen gardens, dairy farming, poultry keeping, pig breeding, food preserving industries and fisheries have to be developed in this country to supply protective foods and animal proteins of high biological value on which the health of the people depends.

#### HEREDITY

Sanitary environment favours the chances of survival of the individual through the application of hygiene, improved medical knowledge and better living conditions. The question how long an individual will live under such conditions will depend on genes inherited by him from his ancestors, which have made them long lived or short lived. So the question of postponement of death and longevity is partly a question of favourable environment and partly of physical inheritance. The genes which are present in the chromosomes of the fertilized eggs are the physical basis of heredity and determine the main path of development as the embryonic growth advances and the individual attains maturity which is accelerated, controlled or altered by hormones. It must be realized that the hormone action itself is a function of genetic constitution of the original cell. Selective breeding has produced new species of seedless grapes and disease resistant bananas. With increased knowledge of the factors of human inheritance in the near future, it is not too much to hope to be able to conserve and perpetuate the quality of human characteristics and traits that are desirable and eradicate the undesirable types and defects in human family through eugenic marriages. Characteristics derived from defective genes are recessive and when union of two germ cells bearing the defective genes takes place a defective offspring is born. It is necessary to know that infectious diseases caused by micro-organisms are not hereditarily transmitted. So syphilis and tuberculosis are not inherited, syphilis, small-pox, measles may be acquired through the placenta. Such infections are due to congenital and not hereditary transmission through the placenta. Heredity relates to the transmission of characters through the genes which are present in the chromosomes of the germ cells. Defects of the nervous system are transmissible, such as insanity, epilepsy, feeble mindedness, deaf-mutism and moral defectiveness. There are also other structural defects such as color blindness, haemophilia, polydactylism, etc., which are also transmitted through heredity. Facts have to be established on the basis of careful observation and experiments whether tendency to diseases or organ inferiorities are transmissible or not. A marked susceptibility to cancer has been noted to exist in the case of certain family groups. Similarly also deaf-mutism. Dr. Fay states that under all circumstances it is exceedingly dangerous for a deaf person to marry a blood relative. Of the eye diseases, cataract has been found to run in families, Myopia and retinitis pigmentosa, a degenerative disease of the retina are hereditarily transmitted. In-breeding which is favoured by caste system will bring up recessive traits and defects in succeeding generations. Cousin marriages and the marriage of the blood relatives should be discouraged if the medical history of the family indicates the presence of defects.

and diseased tendency, such as epilepsy, insanity, degeneracy, feeble mindedness, alcoholism, drug addictness or other hereditary defects among the members or their ancestors

To detect and eradicate such tendencies and defects through eugenic marriages is one of the main aims of preventive medicine in which the medical practitioner should co-operate

#### SOCIAL MEASURES

I have briefly touched on the five sciences which form the ground work of the new science of preventive medicine and which is fundamentally different from environmental and personal hygiene, that is taught in the medical colleges under the designation of Preventive Medicine and Hygiene. The new science of Preventive Medicine would stress the necessity for a periodic medical overhaul of every man, woman and child in order that the health assets and liabilities of each individual might be correctly assessed and a plan of living could be prescribed according to his or her health needs. Sir Arbuthnot Lane has made a very strong case for periodical medical examination in his book entitled "New Health for Every Man" published in 1932. To this end, health centres or what I would prefer to call 'Preventoriums' should be established as a department in every large hospital or by a group of doctors in every large city for the thorough periodical medical examination of all persons who are willing to pay the required fees. At the preventoriums, a careful enquiry should be made into the family history to ascertain the hereditary constitution of the individual and into the personal history with an account of past illness

to determine the immunity status and habits and a physical and a clinical examination with necessary tests should be undertaken to determine (1) the nutrition status, (2) the condition of the organs and of ductless glands and their functions, and (3) the state of the secretions and excretions of the body. Medical history of each individual examined comprising the above data should be kept at these centres for future reference and as permanent records. Preventive treatment and advice to those requiring it should be given at these centres. The establishment of such preventoriums in this country will open a new field in the prevention of diseases and the centres will function as effective agencies for prolonging life and adding to the efficiency and health of the individual.

Insurance companies should require all the insured persons to submit to a periodic medical examination at approved preventoriums. This measure will prove to be a real economic value both to the individual and insurance companies. Indeed such a privilege should be claimed as a right by the insured public. Financial support to such preventoriums should be forthcoming from workmen's associations, co-operative societies and employers of labour, in addition to the support from insurance companies. I am confident that all these organisations will find periodic medical examinations at the preventoriums a paying proposition.

The medical student should receive a practical lesson at such preventoriums and there acquire the preventive outlook and attitude in medicine, and the curriculum of medical students should be revised to include the five basic sciences as an integral part of their course in preventive medicine.

## ASSOCIATION NOTICES

### XXI ALL-INDIA MEDICAL CONFERENCE, CAWNPORE

The next Annual Conference of the Indian Medical Association will be held at Cawnpore on 26th, 27th, 28th and 29th December, 1944. Members of the medical profession are requested to attend the Conference in as large a number as possible in order to make the Conference a great success.

An exhibition of pharmaceutical products, surgical and medical instruments, etc., will be held in connection with the Conference. Those interested in the exhibition of their products are requested to apply to the Exhibition Secretary of the Conference as early as possible.

A Scientific Section is also being arranged where original papers in the various branches of medicine will be read. Scientists and members of the profession are requested to send papers for the same.

For further particulars apply to the Publicity Secretary, Temple of Service, The Mall, Cawnpore.

### VI BENGAL PROVINCIAL MEDICAL CONFERENCE, HOWRAH

The Sixth Bengal Provincial Medical Conference will be held at Howrah on the 26th, 27th and 28th November 1944. As in previous Conferences, many important problems concerning the medical profession, medical relief, A.R.P. measures and public health will be discussed at the Conference.

The Scientific Section of the Conference and the Exhibition of Medical and Surgical products will afford every medical man an excellent opportunity to know the advancement in this country in medical science.

In order to make the Conference thoroughly representative and successful, all members of the medical profession in Bengal are requested to attend and take part in the deliberations.

For further particulars please write to Organising Secretary at 533, Grand Trunk Road (South) Howrah.

### XIV PUNJAB PROVINCIAL MEDICAL CONFERENCE, SARGODHA

The Fourteenth Punjab Provincial Medical Conference will be held at Sargodha this year on the 12th November, 1944. Particulars may be obtained from the General Secretary, Reception Committee.

### BIHAR MEDICAL RELIEF FUND

1 Through Madras Branch, I.M.A.—Rs 825/-, (Dr P. Rama Rau, Rs 100/-, Dr P. S. Varadraj, Rs 50/-, Dr P. T. Raghavachari, Rs 25/-, Lt Col K. G. Pandala, Rs 250/-, Lt-Col T. S. Shastri, Rs 100/-, Rao Bahadur Dr T. S. Tirumurti, Rs 50/-, Dr C. P. Viswanath Menon, Rs 50/-, Anonymous Rs 200/-) 2 Dr Jivraj N. Mehta, Bombay Rs 125/- 3 Dr T. S. Shetty, Ramnad, Rs 50/- 4 Capt. S. C. Sen, New Delhi Rs 250/- 5 Capt. Vidyasaagar, Lahore Rs 100/- 6 The Editors of 'The Anaesthetic', Rs 200/- 7 Through Andhra Provincial Branch, I.M.A., Rs 100/- 8 Dr P. Veeriah Chowdhary, Guntur Rs 100/-

# JOURNAL OF THE INDIAN MEDICAL ASSOCIATION

CALCUTTA, OCTOBER, 1944

## CRUSH SYNDROME

With the end of the monsoon and the advent of a cloudless sky the chances of enemy bombing appear to have increased. We are sure the air-raid precautions in the province are ready for all emergencies and the medical personnel is fully aware of its duties when time arrives. Blood banks have been started for supplying whole blood, plasma and serum to patients as and when indicated. The experiences of bombing are nowhere as varied as in England subjected to incessant raids by the Luftwaffe in 1940-41. During that period observations were made and subsequently confirmed that injuries causing a loss of circulation to limbs and resultant necrosis and sterile autolysis of striated muscle were at times followed shortly by renal failure which often terminated in uræmia. Thorough investigations were made and a definite clinical entity established under the caption "Crush Syndrome", which is an appropriate term for describing these cases.

It is a common experience of the rescue squads that after a heavy bombing it might require hours or even days before the ruins of a building were cleared, and even after such a long interval people are rescued with no appreciably visible injuries. In many of such subjects, however, trouble begins in the span of a few hours. One or more limbs that had been compressed by the debris, begin to get oedematous, lose sensations and motor power. The skin becomes shiny-red and hot. Large muscle-masses of the limbs show positive evidence of patchy necrosis. The oedema is explained by a rapid collection of a considerable volume of plasma in the necrotic muscle. The loss of plasma may be as much as 2 litres, a large quantity indeed. Shock is not a predominant feature, as there is a generalised vasoconstriction preventing a fall of blood pressure in most of the cases. Others respond rapidly to a transfusion of blood or plasma. There is an initial period of oliguria with little changes in the urine except the presence of albumin and a few hyaline casts. Within a day or two of the onset of compression the urine becomes dark or smoky with a brownish deposit. This change in colour and the formation of deposit have been found to be due to the presence of myohæmoglobin<sup>1</sup> helping to form pigmented casts and granular debris. With the passage of myohæmoglobin the total urinary output further decreases and such a state persists in spite of large fluid intake. Acidosis sets in, vomiting is often intractable, and there is a retention of urea and non-protein nitrogen in the blood to a considerable extent. In short, the picture of renal failure is complete and a fatal termination results in majority of the cases within a week. Patients who recover usually start having diuresis in five to six days' time.

In fatal cases, several characteristic features have been demonstrated in the kidneys<sup>2,3</sup>. On gross appearance they are markedly enlarged, present a wet cut surface dripping clear fluid. No abnormal changes are visible histologically in the glomerular capillaries. A non-pigmented, amorphous and granular debris is found in the capsular space and the lumen

of the first convoluted tubule. The epithelial cells lining the first convoluted tubule show a catarrhal condition with desquamation at places. The most notable changes are found in the ascending loop of Henle and the second convoluted tubule. This part of the renal unit and also the collecting tubules contain "pigment casts" which represent the specific feature of the condition. These casts are often numerous and consist of a hæmoglobin derivative, possibly myohæmoglobin<sup>4</sup>. Analogy has been drawn with similar findings in the kidneys in black-water fever, paroxysmal hæmoglobinuria etc. The epithelial lining of the second convoluted tubule and the ascending loop of Henle shows a clear evidence of necrosis (Bywaters and Dible, *loc cit*). In fact, the tubular wall becomes so weak as to allow the permeation of fluid outward. Around these foci of tubular collapse there is also a proliferation of fibroblasts and mononuclear cells. The histological study makes it clear that "the inability of the kidneys to concentrate the glomerular filtrate is related to the loss of structural integrity of the second convoluted tubule". The oliguria is also ascribed to the same cause. The progressive fall in the urinary output is not due to alteration in the filtration pressure as it continues even after the blood pressure rises subsequently.

Examination of the urine shows that urine passed ten to thirty-six hours after admission into the hospital was always strongly acid in reaction<sup>5</sup>. Large doses of alkali are required to bring the reaction to the neutral point<sup>7</sup>. By about the fifth day the urine passed becomes little more than a glomerular filtrate.

The whole clinical picture of crush syndrome or compression anuria has been ascribed to myohæmoglobinuria with blockage of renal tubules by the pigment. But there may be some other factor at work as has been pointed out by De Gown *et al*<sup>8</sup> in connection with similar conditions as black-water fever. Of course, it is of little use to launch a theoretical discussion at this stage. The myohæmoglobin in question is derived evidently from the sterile autolysis of striated muscle tissue. Massive muscular necrosis is a constant feature in all cases in portions of limbs under direct heavy pressure. The necrosis is of the coagulative type. The free effusion of plasma after release causes a rise in the intra-fascial tension and accounts for necrosis to a great extent. Belsey<sup>9</sup> has stressed on a second factor and that is a prolonged arterial spasm which has frequently been detected while doing a decompression operation on compressed limbs.

Blood biochemistry is similar to that of a case of uræmia and in fatal cases the highest figure of urea obtained by Bywaters and Dible (*loc cit*) was 594 mgms per 100 c.c.

The management of a case of compression anuria is bound to be a complicated affair as the problems are not only the tackling of uræmia once it sets in but also prevention of the renal lesion from developing to any great degree by appropriate local treatment. Surgical intervention has got a supreme place in the therapy and muscular decompression, amputation of the limb and finally decapsulation of the kidney (Hadfield and Garrod, *loc cit*) have got to be considered.

<sup>1</sup> BYWATERS *et al*—*Biochem J*, 35 1164, 1942.

<sup>2</sup> HADFIELD AND GARROD—Recent Advances in Pathology, 1942, J A Churchill, London, p 262

<sup>3</sup> BYWATERS AND BEALL, D—*Brit M J* 1 427, 1941

<sup>4</sup> LONGLAND, C. J AND MURRAY J—*Lancet*, 2 158, 1941

<sup>5</sup> DE GOWN, E. L. *et al*—*Arch Int Med*, 61 609, 1938

<sup>6</sup> BELSEY, R. H. R.—*Lancet*, 2 730, 1941

<sup>7</sup> BYWATERS AND DELORA—*Lancet*, 1 648, 1941

<sup>8</sup> MORISON, J. E.—*J Path Bact*, 53 403, 1941

<sup>9</sup> BYWATERS AND DIBLE, J. H.—*Ibid*, 54 111, 1942.

# CURRENT MEDICAL LITERATURE

## CHEMOTHERAPY IN TUBERCULOSIS

The Committee on Therapy of the American Trudeau Society (Medical Section of the National Tuberculosis Association), in session March 17 and 18, 1944, at Chicago and Waukegan, Illinois, has reviewed information so far made available to it on the effects of Promin, Diasone, Promizole, diamino-diphenylsulfone and some related drugs upon previously established experimental tuberculosis in guinea-pigs. It has also reviewed the very limited amount of roentgenological and clinical data from one institution so far made available regarding patients treated with one of the drugs, *viz.*, Diasone. On the basis of these data the following statement has been authorized:

Promin, Diasone, Promizole and certain related compounds appear to possess in varying degree the striking ability to restrain the development of experimental tuberculosis in guinea-pigs. It is recognized that experimentally induced tuberculosis in guinea-pigs offers many contrasts with clinical tuberculosis in human beings, even though the causative organism is the same.

It is the opinion of the Committee that the clinical and roentgenological data so far made available to the Committee on the action of Diasone in human tuberculosis is as yet inadequate both quantitatively and qualitatively to permit, even tentatively, a positive evaluation of its curative effects upon tuberculosis in humans. The Committee believes that there is, at this time, no adequate basis for the optimistic implications of the magazine articles or of the releases to the press which are now so well known to both the profession and the public. It is believed, on the contrary, that such implications are distinctly unwarranted and not in accord with the clinical evidence which has been reviewed by the Committee. The Committee regrets exceedingly that the magazine articles mentioned previously were published in spite of efforts on the part of both the Committee and the clinicians quoted to stop their publication.

Until controlled studies of adequate scope have been reported, it is recommended that none of these drugs be used for treating tuberculosis patients except under conditions which will appreciably add to our knowledge of their clinical action, and in the presence of adequate facilities to protect patients effectively from their potentially serious toxic effects. Patients and physicians must also be reminded of the provisions of the federal regulations which prohibit the distribution of a drug in the experimental phase of development to other than research institutions to which the material is assigned by the manufacturer for either laboratory or clinical investigation. The Committee is informed that other clinical investigations are now in progress, and it is the expressed opinion of the Committee that such further well controlled clinical investigation is distinctly desirable.

Any use of chemotherapeutic agents, including Diasone, in the treatment of tuberculosis patients must, therefore, be regarded as purely a project in that such use is not without hazard and that the roentgenological and clinical evidence reviewed by the Committee gives no justification at this time for any attitude concerning the value of these drugs in patients other than one of critical interest. (*J.A.M.A.* Ed., 125:149, 1944)

## USE OF PENICILLIUM FILTRATE FOR LOCAL TREATMENT

ALSTON (*Brit. M.J.*, 1 655, 1944) in this communication gives the results of the local use of the untreated filtrate in 24 patients. The strain of *P. notatum* was kindly given by Prof. Fleming, and in growing it for this purpose the medium has been changed from time to time, but has always been a modification of the Czapek-Dox formula. At present it is made according to that of Challinor and MacNaughtan without the yeast extract which they recommend and with the addition of calcium carbonate. The following constituents are dissolved in a litre of distilled water:

	Grammes
Sodium nitrate ( $\text{NaNO}_3$ )	3.0
Potassium chloride ( $\text{KCl}$ )	0.5
Magnesium sulphate ( $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$ )	0.5
Ferrous sulphate ( $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$ )	0.01
Potassium dihydrogen phosphate ( $\text{KH}_2\text{PO}_4$ )	6.5
Sodium hydrogen phosphate ( $\text{Na}_2\text{HPO}_4 \cdot 12\text{H}_2\text{O}$ )	33.5
Glucose (pure B.D.H. anhydrous or "Climax" brand, Corn Products Ltd.)	40.0

Distilled water to 1,000 c.c.

Sterilize in free steam for  $1\frac{1}{2}$  hours in 200-c.c. amounts in 1-litre conical flasks. Add 5 c.c. of 10 per cent solution of sterile calcium carbonate to every 200 c.c. of medium before inoculating. The final pH is about 7.

The medium should form a depth of not more than 1.5 to 2 cm in order to expose to air a large surface relative to the volume. Incubation is at a temperature of  $24^\circ\text{C}$  for 8 to 10 days. When the flasks have not been shaken the mould forms a thick firm pellicle and the culture medium below is almost as clear as before incubation. The fluid medium, after growth, is passed through a Seitz filter, and is tested to make sure that the reaction is nearly neutral and that less than 0.1 per cent glucose is left.

The assay of the product is made by comparing its action on the Oxford strain of staphylococcus with the action of a standard specimen of calcium salt of penicillin. The method mostly used is the established one of measuring the zone of inhibition of the staphylococcus around a piece of porcelain tube (containing the penicillin) set on a heavily inoculated plate of agar medium, and occasionally for check, the assay is made by inhibition of the growth of the coccus in broth produced by serial dilutions of the standard preparation and the unknown filtrate (M.R.C. War Memorandum No. 12). The filtrates used for treatment varied in strength from 4 to 10 units per c.c., they do not lose strength when kept at  $4^\circ\text{C}$  for seven days nor when heated to  $65^\circ\text{C}$  for  $2\frac{1}{2}$  hours. More details of the methods used for production and assay are described in a paper by R. M. Sabdeco, which is expected to appear in the *Bulletin of the Institute of Medical Laboratory Technology* in July of this year.

## FOETAL AND NEONATAL MORTALITY IN PREGNANCIES COMPLICATED BY DIABETES MELLITUS

MILLER AND OTHERS (*J.A.M.A.*, 124:271, 1944) give in the following lines the summary of their observations: (1) In pregnancies complicated by diabetes mellitus the foetal and neonatal mortality is about five times higher than that in nondiabetic pregnancies. The foetal and neonatal mortality is as high during the five years immediately preceding the onset of diabetic symptoms as after the syndrome has become established. An increased foetal and neonatal mortality can be observed from fifteen to twenty years can be recognised. (2) Infants with a birth weight of 5 Kg. or more are born to women before they become diabetic with the same high



frequency as after diabetic symptoms have appeared. The incidence of infants whose birth weight is 5 Kg or more is about eighty times higher in pregnancies complicated by diabetes than in nondiabetic pregnancies. (3) The foetal and neonatal mortality is no higher among those infants who weigh 4.5 Kg or more at birth than among those who weigh between 2.5 and 4.5 Kg. (4) In the presence of mild diabetes (not requiring insulin) and in the absence of maternal complications of pregnancy the foetal and neonatal mortality is four times higher than that in the non-diabetic population. Severe complications of pregnancy in women with diabetes increase the risk to the infant. (5) The presence of glycosuria in the last months of pregnancy in women whose carbohydrate metabolism is apparently normal is associated with a foetal and neonatal mortality that is as high as that among the offspring of women with definite diabetic signs and symptoms.

#### THE IMPORTANCE OF FOCAL INFECTION IN OBSTETRICS

SOLIS AND COHEN (*Surg Gynec & Obstet*, Jan 1944) write that the various conditions that obstetricians believe can be caused by focal infection are listed by them as follows: the toxæmias of pregnancy, the nephritis of pregnancy, pyelitis during pregnancy, disorders of the placenta, puerperal sepsis, breast abscess and phlebitis.

Great caution should be observed in removing infected tissue at a focus of infection at all times and especially during pregnancy. Removal of infected tissue at a focus of infection frequently fails to eradicate the infecting organisms, which may continue to multiply and to elaborate toxins and thus keep up the focal infection. The elimination of those microbes may require artificial stimulation of antibody production by the careful administration of a potent vaccine containing the infecting bacteria and their soluble exotoxins.—*U S Office of War Information*

#### SEX HORMONES IN POST-TRAUMATIC PSYCHOSIS IN THE AGED

COGSWELL AND DAVIS (*Am J Surg*, 62 9, 1943, Ref *J.A.M.A.*, 124 59, 1944) point out that not infrequently a senile person placed in bed to recover after some form of trauma, often trivial, breaks down mentally or physically and dies. Many of these patients appear to be in excellent condition up to the time of their injury. Getting these people out of bed as soon as possible and allowing them to exercise is of value in preventing this syndrome. In many cases this cannot be allowed, owing to the nature of the patient's injury. The authors report that 3 patients showed mental symptoms following injuries confining them to bed. Because such mental symptoms were not seen in younger patients under similar conditions, gonadotropic substance was given, and the mental symptoms disappeared.

#### VITAMIN B<sub>6</sub> IN THE TREATMENT OF RADIATION SICKNESS

MAXFIELD AND OTHERS (*Radiology*, 41 383, 1943) administered 25 mg of pyridoxin hydrochloride intravenously to patients in whom a definite radiation sickness was present and in most instances only one injection was necessary to stop the unfavourable symptom. The results have been most gratifying in a series of over 50 cases. The authors recommend that 25 mg be given intravenously immediately after the onset of radiation sickness and repeated after an interval of 24 to 72 hours, as necessary. They maintain that vitamin B<sub>6</sub> therapy should supplement and not replace other methods of treatment and the use of liver extract, a high vitamin intake and sedatives are to be encouraged.

## CORRESPONDENCE

*The Editor is not responsible for any views expressed by contributors*

### ELECTION OF THE PRESIDENT OF THE MADRAS MEDICAL COUNCIL

The Editor, *Journal of the I.M.A.*, Calcutta

Sir,—On 1-7-44 the Madras Medical Council elected Dr V Rama Kamath, as its first non official president, other contending candidate being Rao Bahadur T Satagopan. Dr Kamath got eight votes while Dr Satagopan got three in a council of 15, three members being absent on that day. It is creditable to note that the council observed sound democratic principles in electing the senior most member of the council, who has put in 15 years of meritorious work in the council in particular and also outside for the whole medical profession in general. The Madras Medical Council formerly consisted of seven members nominated by the Government and 8 elected by the profession, now three members nominated while 12 elected. Out of the 12 elected seats three are allotted to the three medical colleges, one for each, and two to the universities. These five members and the three nominated are graduates only, and there is no place for a licentiate among them. The remaining seven seats are thrown open for general election by the profession. The council as it stands now, consists of six licentiates against nine graduates. The Surgeon-General with the Government of Madras had been the nominated president of the council for the last 4 years till 30th June, 1944. When it is so, the election of Dr V Rama Kamath, a licentiate as the first president of the council, speaks very high of his popularity. I heartily congratulate him and wish him long life and sound health. I am etc.

G V Hanumantha Rao,  
Hony Secretary,  
Andhra Provincial Branch, I.M.A.

### SOME SUGGESTIONS FOR MEDICAL REORGANIZATION

The Editor, *Journal of the I.M.A.*, Calcutta

Sir,—With reference to the circular from the Indian Medical Association, Head Office, Calcutta, No. C-26/H S.D.O., I am sending herewith a few of my suggestions for the consideration of the Health Survey and Development Committee appointed by the Government of India.

I feel strongly that the medical organisation needs a complete overhaul, keeping in mind the uphill task that the medical organisation have to undertake in view of ignorance of the general public about the scientific method of treatment. I think the various classifications of system of medical practice, such as allopathic, homœopathic, unani, ayurvedic, osteopathy and so on all in themselves are an adverse reflection on our present day conception of what we call qualified medical practice by a registered graduate. A study of 'History of Medicine' makes it quite clear that the modern development in the medical science, as we understand it by so-called Western allopathic medicine, is a superstructure on the various systems such as ayurvedic, homœopathic, etc.

In India the cry of competition between the indigenous systems and so-called Western medicine is purely a cry of

ignorance against science, wherein the question of a vested interest arises purely from a business point of view rather than from that cherished angle of proper idealism, the relief of the suffering humanity. I, therefore, feel that it is high time when all our energies were pooled to clear up this point in a fashion satisfactory to all. My suggestion for this is as follows—

(1) In the reorganisation for medical education there should be a paper on indigenous system of medicine, both Ayurvedic and Homœopathic, which should be taught as an additional supplementary subject in our department of medicine and pharmacology so that the good points of these systems may be scrutinised in our laboratories and, be within the reach of our medical graduates to fight diseases. It will also root out the quack practice of indigenous systems as well as give great confidence to our ignorant public and impress upon them the value of scientific system of medicine.

(2) All the Unani, Ayurvedic and Homœopathic institutions should be taken over and kept under the Government or Indian Medical Council, so that the proper appointment may be made in those institutions and scientific work encouraged in them.

(3) The present day registered Vaid and Hakims and Homœopaths should carry on with their practice, but for the future the registration should be strictly scrutinised. In due course of time no separate register for them will be necessary as the first suggestion visualises a registered medical practitioner who will have the working knowledge on scientific basis of this indigenous system as well.

(4) It is important that the Government be approached to take steps and see that the word 'doctor' is not used by any one except a registered qualified practitioner. One can commonly see homœopaths styling themselves as 'doctors' and using this in telephone directories, on their signboards and in their prescription forms which largely mislead the public. They can easily write Homœopath, Hakim and Vaid for themselves to avoid confusion.

*General Medical Practitioner*—There is no doubt that the condition of general medical practice is very unsatisfactory. A few points in this connection are mentioned below.

(1) It is absolutely essential to my mind that any difference between licentiates and graduates should be completely dropped out, so that both may work in harmony on a status of full equality.

(2) The private medical practitioners in a town should be given short term appointments in the District Hospitals, so that they may be able to get in touch with hospital work. If possible a tendency towards specialisation may be created in every district hospitals.

(3) Any certificate from a registered medical practitioner whether a graduate or a licentiate, should need no counter-signature from a civil surgeon or an assistant surgeon.

(4) Every possible facility should be given to the private practitioners to attend the Refresher Course in the hospitals.

*Hospital Organisation*—(1) This should be quite separate from the preventive medicine for which the Public Health Department is responsible through its Health Officers and Sanitary Inspectors. I leave that point for one more experienced to deal with in that aspect of Public Health.

(2) I think there will be no difference of opinion that every district at least in this Province, needs an increase in the number of hospitals with adequate staff.

(3) The most important need in any organisation of hospitals in this province is to have proper transport facilities for patients from villages and even in the towns. At least every Sadar Hospital should have one ambulance car with complete outfit. The hospital should have a series of sections in the following groups—

(a) An infirmary for incurable but invalid poor patients according to the local needs.

(b) A mental hospital for all mental cases in the district.

(c) An infectious diseases hospital which is a prime need in this province as cases of small-pox, cholera, leprosy are frequent and very often prove a public nuisance.

(d) A tuberculosis hospital which should have two separate sections, one for medical tuberculosis such as pulmonary, lesions, and another for surgical tuberculosis especially lesions of bones and joints.

(e) A section of venereal diseases which should be popularized and fully equipped to deal with venereal cases.

(f) In those places where maternity and child welfare do not exist it is important that they should be founded.

(g) A reasonable pathological laboratory and x-ray equipment are essential to a district hospital dealing with general medical and surgical cases.

*General Administration*—Adequate number of menial staff, trained nurses and qualified compounders with quarters in hospital premises to live in, proper uniform and adequate pay should be maintained. Compounders and nurses should all be registered. The present day hospital staff is working under very unsatisfactory system of administration.

It would not be out of place to mention that an attempt should be made for the decentralisation of hospital management, in the sense in that in every district, both official and non-official members with adequate representation of medical men may form a board to advise in the administration of hospital as well as encourage the public to donate sums for charity towards the hospital organisation. It is important that every hospital should create the atmosphere and a prestige for itself quite separate from the official attitude of these institutions which make them foreign to the taste of the general public. A great deal of public education towards charity, discipline, dignity of the medical and the nursing professions can be done by adopting some such systems as suggested above to enlist the support of the public, to get the conception, and to create in them a feeling that the hospital is their own institution.

It is also very important that these charitable hospital organisations should be used only by the poor people. Much of the trouble in our hospitals is due to the rich people seeking treatment and demanding extra attention when they have no right to get free treatment (emergencies apart). A definite rule that people above certain income must come to the hospital with a letter from a private practitioner and they should be kept in paying wards where they should be made to pay on a sliding scale according to their income, both for hospital amenities as well as medical attention.

*Medical Education*—There are many suggestions in this connection, but a few outstanding ones are mentioned below.

(1) Medical education in India should have a uniformity all over the teaching institutions in the country in as much as every medical college should have its syllabus approved by the Indian Medical Council. This will give an automatic reciprocity all over the country to the medical graduates.

(2) All medical schools in the country be raised to the standard of a medical college.

(3) All teaching institutions should be managed by academic bodies like the university, and it is imperative that they should be fully equipped.

(4) In every educational institution the time demands that there must be special departments fully grown up and equipped, so that the public may benefit by specialist treatment and the student may get a chance of selecting for himself any speciality having seen its possibilities and advantages. The following specialities are a crying need

(a) Tuberculosis—Medical and Surgical. (b) Skin diseases including leprosy. (c) Venereal diseases. (d) Orthopaedic surgery and physiotherapeutics (bone and joint T.B., occupation therapy and rehabilitation centre. Trained staff for making artificial limbs and splints). (e) Diseases of Children. (f) Diseases of L.N.T. (g) Dental diseases. (h) Neuro surgery. (i) Chest surgery. (j) Anaesthesia. (k) Radiology. (l) Psychological medicine.

(5) A compulsory internship for every graduate who qualifies under a senior medical practitioner or a hospital for at least 6 months before he is allowed to do general practice.

(6) There should be adequate facility for research work in every department, particularly the basic subjects like anatomy, physiology and pathology.

With the above modification in the curriculum it is necessary that large number of research scholarships be offered so that the candidates may select their subjects and

have every chance of post-graduate study and research, both of which are practically non-existent in the scheme of our present medical education.

(7) There should be a post graduate Refresher Course in every teaching hospital for the benefit of the private practitioners.

(8) Post-graduate diplomas and degrees should be organised in every teaching institution in the various specialities mentioned above, so that those who can afford will have every chance of entering into a specialist practice with proper education. This is only possible when every single special section is properly equipped.

(9) The staff in medical colleges should be well paid and there should not be any honorary system. When the essential needs are provided for by a basic pay, then alone it is possible to enforce consultation practice with great rigidity and thus give a chance to the members of the staff to devote themselves to the specialised teaching, post-graduate training and research work.

Time has come when medical problems should be governed by a body as our Indian Medical Council which should have power like the GMC.

I shall be prepared to discuss these points in detail if you or the Health Survey and Development Committee will permit me to take up any of these items and give me a chance of clearing them further—I am etc.

7-7-44

K G Hospital, Lucknow

B N SINHA

M B (LUCK), L.R.C.P. (LOND),  
F.R.C.S. (ENG)

## ERRATA

Vol XIII, No 12, September 1944 issue

- I The references appended to article on Treatment of Cancer with Special Reference to Radiation by K. P. Mody, B.A., M.A. should be read with article on Prevention of Tuberculosis by Bhasker Patel, M.D., M.R.C.P., T.D.D.
- II The summary referred to in Editorial on Penicillin in lines 14-15 of page 349, Column 2, appears in page 15, October 1944 issue.

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## SOME OBSERVATIONS ON ETIOLOGY & PATHOLOGY OF NEISSERIASIS (N GONORRHOEAE INFECTION)

### Its Symptomatology Relevant to Systemic and Urogenital Syndrome

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#### INTRODUCTION

Gonorrhoea is an age-old disease, descriptions of conditions closely resembling it are found in the most ancient, even pre historic writings. From the cuneiform inscriptions lately deciphered it is evident that E-arhaddon, king of Syria (681-668 B.C.) suffered from it. Disconnected, but unmistakable description of the disease are to be seen in the *Ayurvedas* long before syphilis is mentioned in Eastern medical writings.

Gonorrhoea has for long seemed to me to be a misnomer and I venture to hope that other urologists also hold the view that it is a relic of a misconception among others of the origin and pathology of the disease. The term implies a catarrhal condition of the gonads or the genital tract causing an outflow of semen. Light dawned on later observers as we find Avicenna (10th century) opining that the discharge was at least partly due to ulcerations in the urinary tract and later still (12th century) Maïman of Cuno as a result of closer study was the first to observe that the discharge was different in character from semen. If we rechristen gonorrhoea as Neisser's disease, or perhaps better still 'neisseriasis', and the gonococci thus *erani diplococci* we would not only be doing justice to the discoverer of the causal organism, but give the disease the significant and inclusive designation it deserves. Gonorrhoea as will be seen later, is not only urethral or genital infection but it has proved to be a systemic invasion by the neisserian diplococci and its toxins just as leishmaniasis amoebiasis or trichuriasis mean infection by specific organisms. On this analogy neisseriasis would not only be the appropriate but more rational designation for the conditions produced by the organism the disease has been inflicting its scourge on humanity, the causal organisms seemingly unscathed and hardy in human tissues, varying their morphological phases for adaptation and if provocation have been crippling immunity and disabling their host and thus adversely affecting individual efficiency and national progress. And thus has it proved in spite of the labile efforts of scientists and clinicians in the domains of pathology and bacteriology, medicine and surgery. It is a pity that the efforts of the former have been largely in vain and the efforts of the latter have been largely in the direction of curative knowledge of this subject.

In the *Ayurvedas*, the earlier manifestations of the disease are described in detail but the accounting of later conditions, sequelae and complications are scrappy, these being attributed to other causes, the Ayurvedists and Unanists claim that the rarity of complications was due to their non-interfering, symptomatic and expectant methods of treatment and the exclusion of unavoidable trauma liable to be caused by local treatment. There may just be a semblance of truth in it, but the other side of the picture cannot be overlooked. It is more likely that the ever-advancing methods of clinical and laboratory investigations not being available to them, it was hardly possible for them to correlate the later stages of the disease and its causative factors. Let us not, however, underrate the damage caused to the urethra already traumatised by the invading bacteria by uncalled for instrumentation and chemicals by over-zealous urologists. We shall revert to this subject later. It would be interesting though, to refer to the view which places gonorrhoea in the group of self-limited diseases, at any rate in the male. How many of these cases are asymptomatic latent cases and are thus potential 'carriers' of infection are matters for investigation and scrutiny.

#### WHAT IS GONORRHOEA

Gonorrhoea in the male initially implies an outpouring of urethral discharge, a specific urethrorrhoea or mucorrhoea, caused by a specific microbial infection there are however, exceptional cases or 'dry' gonorrhoea, in these cases there may be no discharge or perhaps too insignificant for the casual patient's notice, besides, there is in such cases a fair percentage of 'incubation stage infection'. Laboratory findings in cases of delayed local or metastatic manifestations may indeed be the first clues to the diagnosis. Some of these cases of asymptomatic carriers belong to the groups of the so-called self limited cases or cases having had irregular, interrupted or sub-curative treatment. Gonorrhoea and its complications are thus becoming problems of ever-increasing importance. Close clinical and laboratory investigations of obscure and indeterminate complaints no infrequently lead one to the discovery of neisserian cocci and their associates as the originators. He is a lucky urologist who escapes criticisms for avoidable oversights in these matters. The bare advent of gonococci in the tissues does not induce early clinical symptoms these are produced by toxins liberated by lysis of both the tissue cells (endotoxins) and of the organisms themselves, that is by exotoxins and bacteriolysis. After gonococci complete their life-cycle they undergo lysis and a fresh life cycle process begins and so on. This life cycle process consists of cells with *pathogenic* activity and active phases of the organisms. The result is a discharge consisting of exfoliated cells, with damaged cells (WBC and epithelial cells), plus exfoliated cells, plus gonococci, etc. These gonococci are called extra-

cellular on the subsurface because they work through the intercellular lymph spaces or intracellular which are on the surface. These histopathological facts are based on experimental and clinical data.

Environmental conditions may temporarily alter morphological characters of gonococci caused by biochemical processes though they may eventually revert to their original characters. Take for instance the effects of chemotherapy. Sulphanilamides (S.N.M.) may 'scotch' the gonococci, altering their morphology and their staining and cultural qualities, thereby misleading us, that is why a good deal of caution is necessary in laboratory diagnosis.

The spread of gonococcal infection is not just by mechanical surface or subsurface extension, but by progressive metastasis *via* hematogenous or lymphogenous routes which may eventually give rise to bacteraemia, pyaemia, even endocarditis and in these cases blood cultures not infrequently yield gonococci. Gonococcal urethritis is thus potentially a septicæmic process.

*Case Report 1*—A young married lady with symptoms of septicæmia came under joint consultation (several physicians and surgeons). For the first two days, the usual treatment was not of much avail. Her husband admitted neisserian history to me, tests were made and though the vaginal and cervical smears were negative, her blood culture proved positive to gonococci which gave us a lead to diagnosis and treatment. This is apparently a condition due to gonotoxins liberated by latent foci.

There is a condition of superinfection in gonorrhœa. We shall take three cases (A), (B) and (C). (A) infects (B), (A) can also be infected by (C) by a different strain of gonococci and also by (B) his own strain which may have attained an added virulence or undergone bioblastic alterations while passing through (B).

#### STATISTICAL DATA

American and European statistics give rather astounding averages of all males, 50 to 60 per cent are infected some time in their lives, in large cities and industrial areas, 80 to 95 per cent, 20 per cent of married men have had gonorrhœa, of this 50 per cent sub-cured or latent cases infect their wives or partners.

Ratio of gonorrhœa male and female 16 to 1, complications in women being much higher. 20 per cent to 40 per cent of infected women have their immediate or remote happiness endangered. 25 per cent cases of puerperal sepsis originate in gonorrhœa. 50 per cent of gynæcological operations are for acute or chronic lesions of gonorrhœa. There is a high percentage of chronic semi-invalidism due to local or metastatic complaints in infected women who do not undergo requisite gynæcological treatment, remedial or operational. 25 per cent of all blindness can be traced to neo-natal gonorrhœal ophthalmia. Gonorrhœa not only sterilizes most females but many men. There is a large number of one child or total sterility in gonorrhœic couples.

The above reports are collected from statistical figures of American and European Social Service Organizations co-operating with Public Health Departments. The monetary incapacity and life values of this disease are evidently more appreciated in those countries than by civil administrations here. The casual statistics available here are hardly dependable and accurate. From personal experience of urologists and such

data as are available in V.D. clinics, we are led to think that the total percentage is certainly as high, if not higher, and the incidence of uncured or sub-cured and latent cases would presumably be much higher, among other things, due to marital relations, endorsed or otherwise by social ethics or scarcity of V.D. centres or both. Re-marriages due to barrenness originating in the infected husband's indiscretions are prolific causes of the spread and perpetuity of infection. These are some of our common experiences in this country. The seriousness of chronic gonorrhœa is further emphasised by the long period of its infectiousness, its latency, the uncertainty of cure and want of appreciation on the part of the patient that in order to give him a safety zone assurance, his physician must put him and his marital partner as well through a regular, intensive and full course of treatment, spread out over a long period.

In this connection a few illustrative cases relating to the after effects of chronicity and latency will be interesting.

*Case Report 2*—A young European bachelor, engaged to a girl of a family I knew very well, came to me for the cure of an inguinal swelling diagnosed as irreducible omental hernia, in order to qualify himself for matrimonial fitness. History of V.D. denied. Laboratory tests including urine analysis nothing abnormal. Examination the swelling proved to be varicocele with lymphangiectasis of the left spermatic cord. Operation excision and plastic repair of inguinal canal, uneventful course. A short time after his marriage he reported that he had urethral discharge which he attributed to an infection from his wife. Neisserian cocci found. After anterior lavage and prostatic and vesicular strippings, gonococci were cultured from the fluid. As by this I could convince him of old, latent infection, he admitted that he had urethritis 25 years ago and having been certified cured, he had given me a negative V.D. history. I have always reproached myself for not subjecting him to this test before sanctioning his marriage, particularly with the daughter of an old friend and patient of mine. The wife's infection was fortunately superficial. The husband, quite penitent now, submitted himself to treatment. They are happy parents now. This illustrates how a latent infection is stirred up, years later by early marital sexual activities.

*Case Report 3*—A commercial magnate of Calcutta had several courses of treatment here and for a final course and tests for cure, consulted specialists in the U.K. There, he had varied methods of treatment including vesicular lavage and instillations by vasotomy. He returned to Calcutta with a clean report. Some time after this, ten years after infection, he came under my observation for lumbosacral pain and a vague discomfort in the deep urethra. Slide and culture reports negative. P.R. a few nodes in the prostate. After two weeks of treatment with indifferent results, endoscopic examination revealed minute granulations in the midprostatic urethra. These were punctured and the fluid drawn by negative pressure revealed neisserian cocci. There was no history of fresh exposure.

*Case Report 4*—An army officer in active service had full courses of treatment for gonorrhœa in military hospitals here and pronounced cured. Two years later, when in U.K. on 'home leave' consulted specialists and had further treatment. After some years, when again on 'home leave', had further treatment and with the consultant's permission got married.

Some vague trouble returned soon which roused his suspicion and he consulted me. Urethroscopic examination two soft strictures and chronic lithitis, this caused tender areas in the urethra causing spasms and disturbed micturition. Urethrostrophic massage on a steel bougie yielded a clear fluid negative to slide examination, but positive to gonococci in cultural tests. Wife had cervical erosions but fortunately only secondary organisms on culture.

*Case Report 5*—A married lady consulted for persistent rectal irritation in spite of previous treatment lavage, cautery and even excision of a 'tumour' (?) etc. Examination P.R. mucosal congestion, some epithelial desquamation. P.V. cervical catarrh, on vaginal mucosa, leukoplakial patches. Smear secondary organisms. Culture gonococci. History husband had gonorrhoea ten years before marriage, certified after treatment, fit to marry.

#### THE UROGENITAL TRACT

It would perhaps be desirable to refer to the anatomy and physiology of the urogenital tract in as much as it would concern our present consideration. For a bird's-eye view of the functions of this tract, it may be classified as follows—

(a) Genital, seminal and urinary the penis and the male urethra

(b) Genital and seminal the accessory sex glands namely, the prostate and Cowper's glands and urethral (Littre) glands, the testicles and epididymis

(c) Urinary only the bladder, ureters and kidneys (and the female urethra)

#### THE PENIS

Physiological engorgement and disengagement during erection lead to an interchange of blood between the superficial and deep sets of venous networks, thus, besides the usual lymphatic route of infection, blood from the infected urethral mucosa, submucosa and periurethral tissues may carry infection to corpus penis giving rise to spongeritis and cavernitis. These are anatomical factors, the character of pathological changes depend upon the acuteness or chronicity of the process. Thrombophlebitis and lymphangitis may give rise to acute inflammatory non suppurative phenomena or suppurative processes such as abscesses, fistulae, etc. Subacute and chronic changes give rise to circumscribed and occasionally diffuse fibrosis.

*Case Report 6*—An Anglo-Indian lad after a supposed 'cure' of gonorrhoea had a hectic night with alcoholic and sexual excesses. This was soon followed by a painful swelling in the penoscrotal junction. As the pain and suffering persisted in spite of local treatment, an incision was made by his doctor resulting in smart venous haemorrhage followed by oozing for several days and finally by dribbling of urine for which he consulted us. On examination urinary fistula with a pinhole opening in the centre of an indurated area. Endoscopy a small pointing granulation with a greyish central depression. Healing resulted from endoscopic electrocautery and local diathermy.

*Case Report 7*—A middle aged man consulted us with two independent medical opinions impacted urethral calculus 'most efficacious' of the penis. During a rather stormy case of gonorrhoea his penis got much swollen and painful it never regained its normal size and consistency and there

remained two elongated areas of unusual hardness. Palpation localised, unyielding, woody hardness. Endoscopy some narrowing of the lumen, small patches of leukoplakia. Erection was painful and lopsided, the organ undergoing peculiar distortions. Sexual connection was not practicable and the patient suffered from sex neuroses. Surgical investigation disclosed a chronic fibrous cavernitis.

Another point of anatomical interest is the presence of minute openings of the ducts of the paraurethral glands at the external urinary meatus often requiring magnification to identify. I can recall several cases of urethral auto-infection from organisms harboured in these ducts. This also applies, though perhaps to a less extent, to Tyson gland infections, which are, however, more easily disclosed by palpating the frænum. Other sources of reinfection of urethra are from small papillomata (gonorrhoeal warts), leukoplakial patches on the glans and frænum and old balanitis and balanoposthitis particularly of the chronic desquamating type.

*Case Report 8*—An Officer, 42, married. Very old history of urethritis. Having obtained doctor's sanction after full course of treatment, marries. Wife develops a vaginal discharge and dysuria. Examination cervical erosions, profuse discharge. Skene's tubules point, buds of granulation and leukoplakial patches on mucosa. Slides and cultures positive to gonococci and 'secondaries'. Prolonged treatment lavages, instillations, diathermy and S.W. inductothermy. Vaccine, theelin injections, etc. Later, successive tests negative. Months later, discharge returns and positive tests. On this occasion on examination husband's prostate smear negative, minute papillomata on frænum preputii expressed juice from which was positive to gonococci and secondary organisms. These were desiccated by electrosurgery needle. This has evidently eradicated the evading foci of infection as there have been no other complaints and laboratory tests have been negative since.

#### THE URETHRA AND THE BLADDER

Urologists realise that endoscopic findings and clinical experience do not invariably conform to the anatomist's descriptions. Likewise his deductions regarding the neuromuscular mechanism and hydrodynamics of micturition do not tally with the physiologist's conceptions.

*The female urethra* is entirely urinary in function, is shorter and anatomically simpler. In spite of this, female gonococcal urethritis is not at all uncommon, it often escapes our vigilance and its treatment requires delicate manipulation.

*The male urethra*, however, is a different proposition and its study is important for many reasons. It is a long channel with variations in its lumen which adapts itself to alterations caused by the erectile tissues and extrinsic and intrinsic muscles.

The male urethra may be divided for present purposes into the anterior (spongy) urethra consisting of the meatus, fossa navicularis and the pendulous and bulbous portions and is under the control of its intrinsic muscles and the bulbocavernosus, the posterior urethra having two portions, the membranous part which may be called the 'muscular' urethra and the prostatic part which may be called the 'glandular' urethra. Proximal to this is the vesical neck with its sphincter.

The prostatic portion has two layers of (intrinsic) involuntary muscular fibres, the superficial layer and a deep layer which is in a way incorporated in the substance of the prostate. The superficial layer gives a coating to the urethra

and are carried by it beyond the prostatic portion. Some fibres of this muscle are continuous with the circular muscular fibres of the bladder above and with those of the membranous urethra below. Further, these fibres radiate out into the substance of the lateral lobes of the prostate. Incidentally, it may be mentioned that this muscular arrangement may have something to do with prostatism in the so-called senile prostate. Among other intrinsic muscle fibres may be mentioned muscle bands running from the ureteral orifices and passing through the internal vesical sphincter to the main intrinsic muscles on the floor of the membranous portion.

*The extrinsic (voluntary) muscles* The compressor urethrae, the 'cut off' or 'shut off' muscle which envelops the membranous urethra is by far the more powerful being able to withstand five feet of hydrostatic pressure. This muscle demarcates the anterior from the posterior urethra and in ordinary circumstances, purulent matter, if any, is held back by its tonic sphincteric action. Thus, the anterior urethra is like a blind pouch between the external urinary meatus and this muscle. The bulbocavernosus muscle, otherwise called accelerator urine or ejaculator urinae is a weaker muscle, its function being to eject both urine and semen. The contraction of this muscle being voluntary the point of clinical interest is that a powerful contraction of this muscle might spread infection during the second coitus following shortly after the first. The compressor urethrae muscle is susceptible to mental inhibitions and it is therefore important that its reflex contraction be overcome for endoscopic investigations and intra-urethral medication. If this precaution is ignored, avoidable trauma may be caused to the tract.

*The lumen of the urethra* As it has been said, the lumen of the urethra is variable, the narrowest portions being the external urinary meatus, the necks of the navicular fossa and of the bulb that is, the bulbomembranous junction, in other words the junction of the anterior and posterior urethra. The widest portions are the fossa navicularis, the bulbous portion and the middle of the prostatic urethra. In urethral instrumentation obstruction will naturally be felt in these three narrow calibers. With reference to the feeling of obstruction by the tip of the instrument, it may as well be mentioned here that it may also be caused otherwise, namely by the lacunae, particularly the lacuna magna, due to reflex contraction of the compressor urethrae muscle, and voluntary contraction of the bulbocavernosus and lastly, at an irregular depression into which the superior crista of the verumontanum merges in the prostatic fossa.

*Urethral crypts and glands* In the anterior urethra are located the lacunae urethralis, otherwise called crypts of Morgagni which are indentations or invaginations of its mucous membrane, there are about 20 of them, the smaller ones being situated laterally and on the floor of the urethra and the larger ones in the midline of its roof, the largest being lacuna magna in the fossa navicularis. The clinical importance is that in gonococcal infection, the openings of these lacunae are apt to get blocked and give rise to the so-called 'urethral cysts'.

Littre's glands in the submucous tissue vary considerably in size and number, the larger ones being situated on the roof of the penile urethra. The typical ones are numerous in the anterior urethra, and rudimentary ones in the membranous urethra. These glands discharge their contents into the urethral mucosa and the lacunae. It must be remembered that their

numerous ducts are directed backwards in the penile urethra and forwards in the bulbous urethra. It is of clinical importance to remember this fact while massaging these glands to express their contents and the utility of a back-flow instilling or irrigating apparatus.

*The urethral mucosa* Vulnerability of the urethral mucosa to gonococcal infection and the predilection of the cocci and its toxins for specific types of epithelial cells, have been subjects of much speculation. The submucous connective tissue contains elastic fibres which run into the erectile tissue of the penis and thus establishes an anastomosis between the subepithelial lymph spaces of the mucosa and those of the erectile tissues. The cellular susceptibilities depend on various factors, for instance, the flatter the superficial cells, the more resistant they are, stratification of cells is protective. Drainage facilities, however, would naturally affect infection. The mucosal surfaces of different areas behave differently to gonococci and their toxins. Considering the epithelial lining of the navicular fossa is squamous, of the penile portion as columnar and the transitional type of the posterior urethra, it will be seen that the penile urethra would be more susceptible.

The glandular epithelium of the penile urethra being of columnar or cuboidal type, is considered resistant to contact infection of gonococci, it must be remembered though, that the intercellular lymph spaces carry infection, particularly if there is deficient drainage and cytolysis, exposing these spaces through which the organisms themselves or their toxins may gain access to the glandular elements and then so block the minute ducts as to harbour the organisms more or less indefinitely in the glandular and periglandular tissues. Though the bulbous urethra has fewer glands, it being the most dependent part of the urethra, would hold back infective material in this pouch, and involve those glands.

*The prostatic urethra* demands special consideration. This is the third fusiform enlargement of the urethra and extends from the vesical orifice to the external vesical sphincter, while the roof and sides are fairly uniform, the floor has in it a special structure, the verumontanum which is a spindle-shaped elevation having other designations namely, urethral crest (crista urethralis), colliculus seminalis and caput gallinaginis. It tapers proximally and distally into the superior and inferior crista which after fan-like plications merge into the smooth mucous surfaces above and below. The superior crista ends in an irregular depression called the prostatic fossa, into this opens the ducts of the middle lobe of the gland and is of clinical importance as in instrumental examinations the tip of the instrument may dip into this and find obstruction. At the summit of verumontanum is the sinus pocularis or utriculus prostaticus (the male uterus) which is just a cul-de-sac or recess, narrow below, widening upwards. The ejaculatory ducts passing through the verumontanum opens on either side of the sinus pocularis. On either side of the verumontanum are the prostatic sinuses into which the numerous prostatic ducts open. The verumontanum is of much clinical importance. It has been called the 'sexual heart' and pathological conditions either of its mucosal covering, sinus pocularis or the ejaculatory ducts give rise to diverse clinical phenomena. Endoscopically, spots of granulation or polyp may be seen projecting from the mucosa. Inflammation, cysts and abscesses of the utricle give rise to sexual disturbances, either directly or not infrequently due to reflex effects on the ejaculatory ducts. Occasionally, in the glandular elements of the utricle,

corpora amylacea are found, and in view of its embryological origin from the uterovaginal canal, it may even be an accessory prostate, it certainly produces an alkaline secretion. Though it has been considered by some that excision of verumontanum does not affect sexual functions, practical experience does not support this view as we very often see cases of sexual disabilities originating in lesions in the verumontanum. I shall here relate some cases.

*Case Report 9*—A case of ejaculatio præcox. A young Jew with a history of 'cured' gonorrhœa, suffered from premature ejaculation after his marriage. Therapeutic measures had failed. Endoscopic examination revealed granulations on the verumontanum mucosal congestion. On these being cauterised his power of retention considerably improved.

*Case Report 10*—A case of painful ejaculation. A middle-aged man (married) complained that his trouble which commenced as a vague discomfort during intercourse eventually became quite painful. Nothing abnormal beyond some congestion of the floor of the prostatic urethra was discovered. By applying intra-urethral negative pressure by Alport suction apparatus followed by instillations, this was relieved. No history of extramarital exposure or infection. As his wife had some vague complaints, she was examined and some erosions and ulcers were detected in the os and cervix apparently due to accidental postnatal infection.

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*Case Report 12*—An adolescent lad got into an uncontrollable habit of masturbation and as psychoethical influences and medicinal treatment would not cure it, an endoscopic examination was made which disclosed valvular (congenital) obstruction in the prostatic urethra. This was divided by internal urethrotomy and the urethra dilated which cured him of his masochistic habit.

In some cases similar conditions of the verumontanum proved to be the cause of hematospermia. I remember such cases put right by dilatations and instillations relieving the sufferer of his anxiety due to a previous diagnosis of tubercular spermatozoositis (vesiculitis).

The Bladder is a midway reservoir for urine between the upper and lower tracts, its main function being storage and continence of urine. There is some divergence of opinion about the sectional topography and nomenclature of the free and distensible portion of the organ apparently due to alterations in its colour and disposition according to its fluid content. The bladder has been divided into superior and inferior anterior and posterior and two lateral aspects, the fundus, the dome and its neck and the neck. Naturally, these areas overlap and are not definitely confining. For our purposes it would suffice to divide the superior part as the dome with its summit as apex, the lateral parts which merge into an anterior and posterior (anterolateral and posterolateral) the base or bottom as the vesical trigone and cervix. In cystoscopic examination the visible areas seen in the anterior aspect. The prevesical space called the Space of Retzius is the area between the anterolateral and posterolateral parts of the prostate and bladder to the symphysis pubis to the cervix of the urethra above and posteriorly to the

to the rectum, it is of surgical importance for mobilization of the bladder the areolar tissue contained in it is liable to harbour and spread infection often causing pericystitis.

The bladder has been likened to a toy-balloon with a stem or the most thick piece representing the neck, which forms the internal urinary tractus, of any portion of the bladder it has the most dependant position in the pelvis. This neck can be palpated P.R. round an instrument in the urethra in a line joining the symphysis pubis and the tip of the coccyx, clinically, due to their close anatomical and functional relationships the neck with the trigone and the prostatic urethra constitute a collective diagnostic problem when one or other of the structure is involved. The main portion or body of the bladder is supported by the pelvic floor though it gets some suspensory support from the umbilical ligament or urachus anteriorly and the two ureters postero-laterally. Its neck, however, is better supported and in a way fixed anteriorly by the pubovesical or puboprostatic ligaments which are fibromuscular bands, and posteriorly by strong rectovesical connective tissue.

The mucosa of the bladder lined with transitional epithelium is suitably adapted for all stages of contraction and dilatation of its walls. It does not contain any glands, the gland-like appearance seen on cystoscopic examination represents small submucous cysts known as 'cystitis cystica' which originate from the cell-nests of von Brunn. Muciparous glands are rare abnormal structures in the bladder wall and may be of prostatic origin (accessory prostates).

The musculature of the bladder is confusingly interesting. The detrusor urinae, constituting the main thickness of its wall is a continuous muscular wall, it can be but indefinitely distinguished as a middle circular and external and internal longitudinal layers as the direction of fibres vary according to the degree of distension of the bladder. These different fibres take their origins below from the pubic bone the base of the prostate and the neck of the bladder itself and spread upwards in an interlacing manner. In distal urinary obstructions, the fibres are liable to undergo hypertrophy and may vasculature giving rise to trabeculations of the bladder wall and protrusion of its mucosa resulting in sacculations which may harbour phosphatic and other concretions and detritus seen on cystoscopic examinations. The circular layer is the more complex of the three and the longitudinal fibres are thickest in midline. The three layers may be collectively considered as one muscle, they form the detrusor ring at the neck which contribute substantially to the internal sphincter and is fixed to the symphysis pubis by the pubovesical (puboprostatic) ligaments and serve as an anchor. The longitudinal bands enter the vesicoprostatic groove encircle the urethra in loops to form the external urethral loop though called by Henle the 'external vesical sphincter', these apparently represent the urethral sphincter, they contribute to the muscular elements of the prostate the submucous urethral layer and to the muscular fibres of the neck in a circular manner. They also compose the muscular fibres of the pubovesical ligaments. The internal vesical sphincter is no circular but of a complex disposition, it acts as an involuntary muscle to close the outlet of the bladder and continues to act even after prostatectomy and dissection of the external sphincter.

The trigonal muscle is formed by a fanwise spreading of the longitudinal fibres on the dorsal aspect of the ureters. It is a triangular muscle, its base is the symphysis pubis and its apex is the tip of the coccyx, its fibres are directed towards the ureters and the bladder neck.



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The trigonal muscle is formed by a fanwise spreading out of the longitudinal fibres on the dorsal aspect of the ureters. The two ureters are separated by a fold of peritoneum forming the ureteric foveolae and later end as loops in the prostate urethra to

combine with the detrusor fibres of the neck. The anatomical disposition of these muscle bundles indicates that the trigonal region belongs to the ureters and the urethra and has become incorporated in the bladder. The striated and unstriated sphincteric fibres beneath the trigone, in a way, represent the muscular wall of the posterior urethra and take a significant part in the action of the bladder muscle in the sphincteric mechanism.

The external sphincter is formed of striated muscle and is composed of three parts: (1) the portion from the anterior surface of the prostate running in a circular manner to its apex where they encircle the urethra, this has been called the 'sphincter externus vesicæ', (2) the urethral portion between two layers of triangular ligament, apparently a number of the prostatic fibres, enclosing the membranous urethra to meet in the posterior raphe and is the 'compressor urethræ' muscle, and (3) the urogenital portion of the deep transversus perinei muscles on either side (Guthrie's muscle) also between the two layers of the triangular ligament.

In this connection we have to consider other urethral and perineal muscles, namely the bulbocavernosus (accelerator urinæ), the prostatic fibres of the levatores ani, the rectourethralis and the urogenital diaphragm. These structures act as accessory factors in giving continence and in initiating and completing the act of micturition.

Thus the hydrodynamics of micturition, that is continence and voiding of urine consist of complicated and somewhat obscure mechanisms and as we are confronted with cases of dysfunction in urogenital infections, particularly in gonorrhoea, we shall summarise the present day knowledge of this subject. The two processes depend on the complex action of several reflexes and are disturbed in urogenital infections and their after-effects.

Continence of urine in the bladder depends on—(1) Involuntary relaxation of the detrusor muscles, (2) tonic and possibly, voluntary contraction of the internal sphincter, (3) voluntary contraction of the external sphincter, (4) voluntary contraction of the accessory muscles of the urogenital diaphragm.

The factors involved in the act of micturition or emptying the bladder consist of the following: (1) Straightening of the prostatic urethra by voluntary depression of the internal sphincter. (2) Relaxation of the two sphincters and contraction of musculus trigonalis and pubovesicalis, thus releasing the mechanism of closure. (3) Contraction of detrusor muscle synchronously with trigonal contraction which in a way invaginates the upper pole of the bladder into its cavity. (4) Increase in intra-abdominal pressure by the contraction of abdominal muscles and the diaphragm simultaneously with the detrusor contraction. (5) Completion of the act by emptying the bulb by ejaculatory mechanism which empties the urethra and avoids dribbling.

This mechanism of micturition has been likened to the functions of a double-bulbed syringe, the proximal bulb being the bladder and the smaller distal bulb, the bulbar urethra which superimposes the barrel of the syringe.

Though the bladder holds urine even for long periods, in human beings with a normal bladder there is not much evidence of fluid absorption. Some drugs, it is said, are absorbed by the normal vesical mucosa. The posterior urethra on the other hand is much more active in absorbing. Inflammation (cystitis)

renders the bladder permeable. Alkaline urine is more likely to be absorbed than acid urine and has been supposed to cause absorption-uræmia.

Functionally, the trigone (*trigonum vesicæ*) presents some interesting features for consideration. Its musculature (*musculus trigonalis*) plays an important part in its structure and functions. The longitudinal (smooth) muscle fibres of the dorsal walls of the ureters spread fanwise and anastomose in the middle to form the *musculus trigonalis*, pass through the detrusor ring of the bladder, and as urethral loops terminate in the prostatic urethra. In their passage, they leave some anatomical landmarks as viewed by the cystoscope. Its interureteral ridge forms the upper boundary of the trigone (Mercier's bar). The fibres pass obliquely down from the lateral ends of ureteral ridges, (Bell's muscles) and as they converge at the apex, they form a rounded elevation on the mucous membrane, known as Lieutaud's uvula to terminate in the prostatic urethra. The *musculus trigonalis* being superimposed on the detrusor muscle of the bladder renders the trigone the thickest part of the bladder wall. The trigone has no submucosa, the smooth mucous membrane being firmly attached to the muscular coat and irrespective of vesical dilatation, it does not turn into folds like the mucosa of the bladder wall. This and its deeper red colour which renders the underlying blood vessels less distinct distinguishes it from the rest of the bladder mucosa.

The trigone almost invariably bears the brunt of infection of the bladder often associated with neglected or meddling treatment of posterior urethritis. The bladder which is lined with transitional epithelium and is freely dilatable is much less frequently infected unless there is urinary stasis and chemical or instrumental trauma. On the other hand, the fixed and undilatatable trigone is more readily infected, particularly if the so-called trigonal glands are involved but somehow or other it manages to get rid of the infection if posterior urethritis and distal obstructive elements, if any, are remedied. Trigonitis in women is a common complication of adnexitis and the latter must be treated for a cure. Pain at the end of micturition when the bladder contracts down on the trigone, felt more in the day than at night is a common symptom of trigonitis. The urine may be clear with a few WBC, but, with some RBC 'floaters' and shreds are seen in chronic cases. Cystoscopy which should be undertaken with caution and care, reveals its intensely red and hyperæmic mucosa which is quite in contrast with the appearance of the bladder mucosa if it is not involved.

With reference to the hydrodynamic process of the urogenital tract, a few further facts which may explain abnormalities in the flow, that is the proximal to distal current, are worth mentioning as these may have important precautionary bearing in infections of this tract. The flow is initiated, directed and controlled by intramural and extramural pressures and by gravity. For clinical considerations, backflows from the urethra, the bladder and the ureters are important but for present purposes urethrovvesicular and vesicoureteral reflux will be considered.

Urethrovvesicular (seminal) reflux is not uncommon with abnormal openings of the ejaculatory ducts or if there is reversed peristalsis. In these conditions urine and septic contents of the urethra may find their way into the ducts and the vesicles and explain recurring vesiculitis.

The mechanism of vesicoureteral regurgitation is quite interesting. The ureteral tubes with thick muscular wall perforate the muscular coat of the bladder obliquely at slightly

varying angles and open at either end of the inter-ureteral ridge, its muscle fibres eventually contribute to the trigonal musculature. The intramuscular part of the ureter between the narrowed juxta-vesical portion and its orifice is spindle-shaped (Blum's ampulla) and at its emergence is the ureterovesical valve, a lip-like structure, these provide the mechanical factors against the backflow of urine into the ureters. Normally, during micturition, the ureteric valve is quiescent. The efficiency of the valve depends on the normal thickness and functioning of Bell's muscle and the muscles of the trigone and the bladder. In some conditions the action of the valve is not sufficient to prevent regurgitation into the ureter, this may happen during anaesthesia, particularly in children, when a patient is placed in the knee-chest position, if the urine is voluntarily held in the bladder, and during ureteral catheterization. It may also happen in certain pathological conditions, such as trauma or irritation (cystitis, vesical calculus, etc), back pressure in distal tract obstruction, either urethral or prostatic or due to the presence of congenital valves, etc. and in conditions of neuromuscular disturbances. In this connection some clinical facts have to be noted during treatment and instrumentation, for instance, the necessity of aseptic precautions in ureteral catheterization or in the presence of cystitis and mechanical irritation of the bladder by vesical calculi instrumentation etc the possibility of reflux and ascending infection is borne in mind, further, during urethrovessical lavage, over-distention of the bladder or asking the patient to assay micturition when this is being done, reflux can take place. In suspected infection of the lower end of the ureter, initial knee-chest position of the patient and change back into dorsal position is helpful to allow the antiseptic solution which had entered the ureters to escape, this to some extent would wash out the ureters, at any rate their distal ends.

*To be continued*

*(Continued from page 32)*

"The symptoms do not correspond to the pathological condition. Cases with mild symptoms may have a gangrenous appendix while those with extreme rigidity of the abdomen and rise of temperature may have a relatively mild inflammation. Constant vomiting is a bad feature.

"If the abscess has to be opened, it takes about six weeks before it heals up and still the appendix has to be removed at a later date. In children and in those who have taken purgatives, the operation is imperative. Obstructive types also require urgent removal of the appendix. The mortality of early appendicectomy is negligible and the convalescence is uneventful."

*(Continued from page 28)*

**Contacts**—It is an uncontroversial fact, that opportunities for contact are the most prolific sources of infection, and Lucknow does not lack in such distributors of the disease.

#### REMEDY

Here are some suggestions which would help the simplification of the tuberculosis problem in Lucknow. These are based on the experience gained by personal contact with tuberculous patients and families. Lucknow is a model city of our province, and can serve as an example in bringing out the difficulties encountered by other cities of our province. The statistics surveyed above and the suggestions to follow, can apply to any other place of our province with only slight modification according to local needs.

1 The immediate opening of an up-to-date T.B. clinic.

2 Segregation of the reservoirs of infections

(a) Hospitalisation for treatable cases. The T.B. hospital should be started without delay.

(b) Colonization—(i) Incurables (ii) Occupational therapy and supervision of persons discharged from sanatoria.

3 Raising the age of infection.

The aforesaid survey has revealed that the age of maximum infection is between 8—11 years. If we can tide over this age the defence forces of the body will be better suited to conquer infection, and utilize it as an aid to immunization. This can be done by

(a) Preventing our children from coming in contact with open cases of the disease. (b) The free supply of milk practised in Lucknow, be more to children of 8—11 years. At the same time the quality of milk supplied to children in general be better controlled. (c) Encouraging outdoor games in Classes VIII, IX and X. (d) Propaganda amongst the public that T.B. patient is very dangerous for children. (e) Regular health examination of students of Classes VIII—X.

4 Organized home treatment to be universally adopted.

5 Hygiene to be a compulsory subject and teachers chiefly of primary schools should be periodically lectured and examined for the knowledge of practical hygiene.

#### ACKNOWLEDGMENT

Before concluding this paper, I would like to express my indebtedness to U.P. T.B. Association for the help given in conducting the tuberculosis survey and to Doctor K. N. Shukla for his assistance and advice throughout this work.

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## TUBERCULOSIS PROBLEM IN LUCKNOW\*

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### INTRODUCTION

To trace our age long relationship with the tubercle bacillus, and stressing the magnitude of the tuberculosis problem in India, will be harping on an old tune and unnecessarily wasting your precious time. In the following words I shall put before you some facts that have been collected during 1941 and 1942, by personal contact with tuberculous families, and from the observations of a series of Mantoux tests performed on 5,012 healthy persons in Lucknow.

Lucknow as most of us are already aware is an ancient city and has witnessed the pomp and grandeur of the Nawabs and Begums of Oudh as their capital. Even to-day it is considered to be the most aristocratic city of the province. The area of Lucknow municipality is 18 square miles and was inhabited by 3,54,560 persons in 1943. The influx of evacuees from Burma and Calcutta has raised the population figures to over 4,00,000, which works out to 125 sq feet per head. In spite of the fact that the municipal board spends 18.06 per cent of its total income on public health measures, the death rate is still alarming, i.e., 26.01 per thousand. Out of this, in my estimation, tuberculosis is responsible for at least 1/6 of the total number of deaths per year, when Lucknow is known as the city of parks, there being 65 public and more than 500 private gardens, which no other city in India can boast of having.

It is practically impossible to estimate correctly the amount of medical aid available to ailing thousands in a city where Hakims, Vaid, Homoeopaths, nature cure clinics and psychotherapists abound. No one can deny that some of them know their job well and their popularity attracts a large crowd of the sick. The following is a list of the well known centres of healing, but there may be many more which inspite of meticulous search have remained untraced—

Hospital for scientific medicine—7, dispensary, out-patients—7, vedic dispensary—13, Tibbi hospitals—7, homeopathic hospitals—15, practitioners of scientific medicine—150 and hakims and vaid—200. Homoeopaths are innumerable, practically one out of every ten clerks employed in different offices practices homoeopathy.

The sad fate of tubercular patients, needs our full sympathy when we try to find out places specially devoted to the care of the tubercular patient and his family, there being only 24 beds in the King George's Medical College Hospital. The opening ceremony of the T.B. Hospital built 7 years ago is still awaited. The only provincial institution for the treatment of T.B. cases is at Allahabad.

There are 5 types of survey as annunciated by Tuberculosis Survey Sub Committee of India but I will restrict myself to type 1 survey only. The purpose of this type of survey is to ascertain the distribution of tuberculosis infection in a particular area and to find out special groups where further investigation is particularly needed. The test of Mandel and Mantoux which has been approved by the Tuberculosis Survey Sub Committee of India, should be employed. It is practically impossible to test each and every person in the city or town

and therefore, utmost care should be taken to ensure that the samples tested are as representative as possible.

It has been my privilege to undertake a Survey Type I in the city of Lucknow and this paper is based on the experience obtained in the same.

*Difficulties*—Before actually starting the work all the preliminaries must be settled. In my work much time was wasted in correspondence with the authorities concerned and personal assurances regarding the after effects of the inoculation. In spite of all this a few could not be persuaded to allow this harmless investigation to be carried out in their institutions. For example, in a mill in which this test was performed on 20 people in the first instance as a sample, not even a single individual suffered from any symptom whatsoever nor was incapacitated in any way. I was not permitted to carry on the work due to the danger of employees malingering. Others were more helpful. They had no objection after such demonstrations. In some places I must admit, the authorities adopted a very helpful attitude from the very beginning. This was so, mostly, in schools where on seeing the reluctance of the students to submit to an injection, the teachers volunteered first.

Malingering on the part of the subjects is an obstacle to be encountered.

Among children and a few adults the mere mention of an injection is frightening. No amount of persuasion will make them change their mind, and I think it best to ignore them, otherwise it sets a bad example and dissuades others. These conscientious objectors should be tackled once again at the finish of the work.

Usually the reaction should be observed after 48 and 72 hours, and if it is negative at the end of 72 hours, the verdict of Mantoux negative is justified. But in my series, it was observed that a one plus positive reaction persists for one week, a two plus for two weeks, three plus for three weeks, and four plus reaction can be easily detected after a month, the latter two, very often leave a mark which lasts for more than three months. Therefore, to say that all those reactions that are observed and recorded after 72 hours are wrong, is incorrect. In case a higher dilution is to be given to a negative case, it should be done within a week of the first.

### SELECTION OF THE AREA AND SUBJECTS

As has been said before it is practically impossible to test each and every person in the town or district. Moreover, house to house survey will be useless because in order to compare the extent of infection in the different areas or communities it will be more helpful to obtain a correct estimate of the fresh infection rate. For this purpose, younger age groups will serve better. In our investigation, therefore, the test was performed on the students of the primary schools, and the lower classes of the secondary schools. Primary schools are moreover distributed all over the town and hence all the areas are automatically subjected to the investigation. The subjects tested are similar age groups thereby facilitating the comparison of the infection rate in the different areas and communities, and assessing the importance of any factor that might be held responsible for any appreciable difference in the same. The representation of the adult persons and people of advanced age must also be secured. For the former the students of higher classes in the secondary schools and intermediate colleges will answer best while for the latter the co-operation of the employees in some of the offices should be secured.

The problem of assessing the infection rate in females

\*Read at the IX U.P. Provincial Medical Conference at Gorakhpur, October, 1943

is very difficult. Adults and old women cannot obviously be available for examination

#### RECORDING OF REACTIONS

The results should usually be noted after 72 hours but as pointed out before the positive reaction remains so for a few more days and can be classified into the groups according to the severity of the reaction. For noting the size the longest meridian should alone be considered.

It is of great interest and should serve as a sound warning for the survey worker to note some unusual reactions met with during our survey.

Flaring of a previous negative response after inoculation of a higher dose were noted in six cases of this series. As a typical example I would cite the case of a Hindu male who was completely negative to the first injection but when a higher dilution was given in the other arm, both arms showed a positive response after 72 hours of the second injection.

Local immediate urticarial response was observed in five instances. Two cases of anaphylactoid reaction were observed. Within a few minutes of injection the person felt giddy, became pale, burst out in a cold sweat and became semi-conscious. He was given cold water and felt better after 15 minutes. When observed after 72 hours there was the usual two plus reaction. One case of a hysterical nature was observed.

I would also like to point out that in dark skinned people, one is likely to miss a positive reaction if he depends on sight alone. The slight induration raised above the surface can best be felt by passing the fingers over the area injected.

86 per cent of the positive reactions become manifest after the 1:1000 dilution while the remaining 14 per cent require the 1:100 dilution. Out of the latter, 3 plus and 4 plus reactions comprised only 2.5 per cent and 0.6 per cent respectively. It was noted that most of the severe reactions were exhibited by the younger age groups. Thus subjects below 15 years accounted for 78.5 per cent of the 4 plus and 76.3 per cent of 3 plus reactions.

Necrosis was present in 45 cases and vesiculation in 110. The number and size of the vesicles varied a great deal. In a few there was a single blister while in the majority there were multiple small vesicles varying from the size of pins head to that of a pea. A stage milder in intensity was soddening and wrinkling of the skin around the site of inoculation.

#### SURVEY RESULTS

With a dense population and high death rate we cannot, but expect, to find a high rate of infection. The tuberculin test of Mandel and Mantoux with OT confirms our apprehensions.

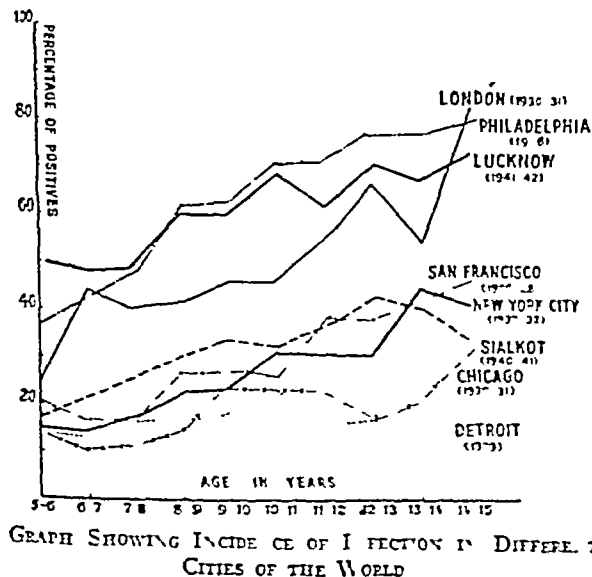
Age Group	Total Cases	No Positive
Up to 5 yrs	14	3 (21.4%)
6-10 "	1502	833 (55.5%)
11-15 "	1019	687 (67.5%)
16-20 "	636	492 (77.4%)
21-25 "	318	267 (84.0%)
26-30 "	515	437 (84.9%)
31-35 "	383	329 (85.4%)
36-40 "	257	228 (88.8%)
41-45 "	114	102 (89.5%)
46-50 "	89	80 (89.5%)
51 & above	165	150 (91.0%)
Total	5012	3505 (71.9%)

These figures are alarming indeed, but do not help us much in ascertaining if the disease is stationary or has increased, because we do not know the incidence of infection in the past.

Tuberculo-sensitivity is absent in early life and the percentage of positive reaction increases as we go up the ladder of life. Tuberculo-sensitivity is specific and cannot develop without contact with the tubercle bacillus. Thus, if we analyse the above mentioned statistics still further, into each year of age, we would find, as to which age the contact is most, and the anti-tuberculous measures if applied to that period of life, would bear fruit. This is easy to calculate, if it is kept in mind that a person once positive remains so throughout his life, the extent of allergy may vary from time to time but exists practically forever in that person.

Age	5-6 yrs	50.9 per cent	positive
6-7 "	49.6	"	"
7-8 "	48.8	"	"
8-9 "	60.1	"	"
9-10 "	61.2	"	"
10-11 "	68.9	"	"
11-12 "	72.5	"	"
12-13 "	71.5	"	"
13-14 "	68.0	"	"
14-15 "	73.5	"	"

From the above table it is clear that the maximum number of fresh cases occur between the ages of 5-10 years and diminish gradually as we go up the scale of life, maximum being between 8 to 11 years. After that age the amount of fresh infections diminish due to the fact that most of the people have already developed a positive reaction, thus proving that most of our children are tuberculinized through contact of the infection in the house. Assuming Von Behring's doctrine that phthisis is the last verse of the song started in the cradle, to be only partly true, we should prevent our children between the ages of 9-11 from coming in contact with open cases of the disease, raise their general health, and direct anti-tuberculosis measures to be adopted during that age.



Before we get panicky and over-awed by the magnitude of the tuberculosis problem in Lucknow, let me tell you the state of affairs in other places of India and the world. This will be evident from the annexed table.

The accompanying graph shows this better, and by glancing at it we take a sigh of relief in that Lucknow is not so badly off, as one would conclude by examining our figures alone. It also shows that Cochun China and Philadelphia are worst, while in the age group of 5-10 years there is not much difference in our, and the children in London.

71.9 per cent of the total population of Lucknow is infected, the corresponding figures in Cochun China are

76.8 per cent, London 95 per cent and France 89 per cent. Chicago, Detroit and New York have the least infection. As the result of a strict, scientific and persistent anti-tuberculosis campaign in U.S.A., large percentages of young adults are now being discovered to be tuberculin-negative when they are entering the colleges and universities.

#### CAUSES OF HIGH INFECTION

No discussion about the tuberculosis problem can be complete unless we decipher some of the causes of such high infection and suggest some measures for overcoming them. To say that in a malady like tuberculosis, disease is directly

TABLE SHOWING PERCENTAGE OF INFECTION IN DIFFERENT PLACES

Age group	New York City 1930-32	Chicago Illinois 1930-31	Phila- delphia 1926	Detroit Michigan 1929	San-Fran- cisco 1925-28	London 1930-31	Lucknow 1941-42
5-6 yrs	14.5	13.0	37.7	13.3	20.6	24.4	50.9
6-7 yrs	14	10.0	43.1	12.6	16.5	44.3	49.6
7-8 yrs	17.3	10.7	47.7	16.0	16.1	40.6	48.8
8-9 yrs	23.1	14.4	62.2	17.1	16.4	42.0	60.1
9-10 yrs	23.7	23.6	63.5	18.1	27.7	46.2	61.2
10-11 yrs	30.4	23.6	70.9	22.4	26.2	47.3	68.9
11-12 yrs	31.1	22.6	73.1	15.3	38.0	54.4	62.0
12-13 yrs	31.2	16.1	77.6	16.7	39.1	66.7	71.0
13-14 yrs	44.1	22.1	77.9	28.3	42.2	55.0	68.0
14-15 yrs	42.1	30.5	79.9	16.7	46.6	82.2	73.5

Age group	Lucknow	Cochun China	France	London	Minne- apolis
5-10 yrs	55.5	—	—	39.0	35
10-15 yrs	67.5	64.75	81.9	58.3	57
Total	71.9	76.89	89.0	95.0	—

proportional to the infection will not be the whole truth, since there are other factors which play an important part in an infected person becoming a patient of active disease. The important factors, which favour this change are age, urbanization, socio-economic conditions, knowledge of essentials of hygiene and contact with open cases.

I would now consider as to how much they are responsible for the disease in Lucknow.

**Age**—The age of maximum fresh infections is between 8-11 years, and by the age of 25 years 84 per cent are infected with tuberculosis. This shows that 2/3 of our children contract the infection before leaving the school.

The average age of the student appearing in the high school examination is 12½ years and the local schools, in order to show comparatively better results, have raised the standard of examination of the 9th class. This means a great strain on the students' health at the age of 11 years. The report of School Health Officer, Lucknow, points out the high incidence of throat infections in our school children, which is a predisposing factor. Games and outdoor exercises are only popular in the primary classes or the colleges. Hence the tubercle bacillus finding a fertile soil in a child with low vitality thrives well.

**Urbanization**—Opportunities for infection, are of course more in cities than in rural areas. Lucknow cannot boast of being a great industrial city, on the contrary, it has three mills of any significance. It is the seat of Government, higher education and has a reputation of being the best place for the

welfare of the sick. Efficient railway and bus service connects Lucknow to distant rural areas. The commonest recreation is the cinema and it is estimated that 25,000 persons visit pictures daily. The report of the Municipality for 1942 tells us that the buildings in the eastern areas are ancient, with insufficient ventilation increasing respiratory infections. Hence there is a great admixture of population with consequent risks of transmission of infection from one to the other.

**Socio Economic Conditions**—The mean income of a citizen of Lucknow is only 6.21 rupees (according to census of 1941). The standard of living of an individual is directly proportional to his income. And so the aim of a Lucknowite is to make both ends meet, irrespective of the quality of the diet, personal hygiene and clothing.

Customs and traditions are the basic principles of our existence. Smoking a *panchayat hooka*, drinking water through a common glass, strict *purdah*, compulsory visits to the sick, reluctance to disclose the family history of tuberculosis, keeping the diagnosis a secret from the patient and early and frequent child bearing (which incidentally seems to be the result of the only pleasant pastime, the poor can indulge in) are some of the handicaps which our social workers must tackle soon. Everyone of them is a contributing factor in the distribution of tuberculosis.

**Knowledge of Hygiene**—During our visits to primary schools we were sadly disappointed to note that even the teachers of such institutions were unaware of the elementary essentials of hygiene. Even in colleges the teaching of First Aid to the Injured was considered as the limits of hygiene. 80 per cent of the population of Lucknow still think that tuberculosis is a hereditary and incurable disease, not knowing that T.B. can be completely cured if treated properly from the earliest stage, 90 per cent of our adults contracted the infection, but have saved themselves from progressive disease.

(Continued on page 25, col 2)

# CHRONIC ECZEMA AND ITS TREATMENT •

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## INTRODUCTION

It is useless to emphasise the importance and frequency of eczema, especially the chronic type in general practice or in a skin clinic. All cases should be thoroughly and very carefully investigated, taking full notes of their previous and present history, etc. Scales from the lesions are to be examined in each case under microscope and usually in the absence of mycelial threads or spores—eczema should be diagnosed, although fungoid infection of the skin can produce eczematous lesions, they have got more or less defined margins.

The aetiology of eczema is rather obscure. The recent view is that it is due to some degree of external irritation, acting upon a skin sensitized by some endogenous or constitutional poison derived either from some focal sepsis lurking under the teeth, tonsils, accessory air sinuses or the nose, in some diverticulum of the alimentary canal, gall-bladder, pelvic organs or due to some disturbances in the secretion of endocrine glands. This is why some authorities name eczema more correctly as 'sensitization dermatitis'. The conditions from which one must distinguish eczema are (1) Traumatic dermatitis (2) industrial dermatitis, (3) psoriasis, (4) scabies and (5) lichen the details of which I need not put down here. History and microscopical examination will differentiate them from true eczema. The family history frequently reveals that a near relation of the patient is or was prone to allergic reactions, particularly eczema, asthma, or some systemic diseases, as diabetes, gout, nephritis, etc.

During my attendance in the Skin and Venereal Department of the Lady Willingdon Raj Hospital for the last 7 years, I found that chronic eczema with periodical or seasonal relapses was very common and troublesome to treat.

Truth speaking there are many points in the aetiology and treatment of chronic eczema which are not yet fully understood. 50 consecutive cases of chronic eczema were studied during 1940-42, the resume of which is as follows.

## ÆTIOLOGY

(a) Age—Number of cases with age and duration of disease.

Age	Duration	No of Cases
2½ to 6 years	2 months to 1½ year	8
7 to 17 years	4 months	1
18 to 25 years	3 months to 2 years	4
26 to 45 years	4 months to 16 years	29
46 to 65 years	1 month to 32 years	6
66 to 79 years	8 years to 27 years	2

The youngest was of a boy aged 2½ years and the oldest a man aged 79. Out of 50 cases 35 i.e. 70 per cent fall within the age period 26 and 65, duration varying from 4 months to 32 years.

(b) Sex—Out of 50 cases only 5 were female patients showing a proportion of male to female as 9 to 1. In one instance I found that in a Marwari family, two brothers aged 3 and 11 years got the disease but their sister aged 6 is still

free. Their father aged about 45 gave history of gout and chronic dyspepsia for the last 10 or 12 years.

(c) Site and distribution—Out of 50 cases, hands and feet were involved in 35 cases, i.e. 70 per cent suffer from chronic eczema of hands and feet. Next common site is the scalp, neck and face, 10 per cent.

Site	Distribution	No of Cases
Scalp, neck and face	round or oval patches	5
Hands (mostly palmar aspect)	8 bilateral	14
Legs and feet	9 bilateral	21
Armpit		2
Round the anus		1
Round the waist		2
Other parts of the trunk		5

(d) Family history—Out of 50 cases, 14 gave family history of asthma, 13 of gout, 7 of chronic eczema, 3 of chronic dysentery or dyspepsia. Thus 74 per cent gave some definite family history and the rest did not.

Cases suffering from some systemic disease can be analysed thus.

Associated Systemic Disease	No of Cases
Gout	3
Diabetes	2
Asthma	8*
Nephritis	1
Enlarged tonsils	2
Pyorrhœa	4
No abnormalities detected	30

\* Out of these two were children.

Out of 50 cases, 8 i.e. 16 per cent cases suffered from asthma and 6 per cent from gout, either with or alternatively with chronic eczema.

## LABORATORY FINDINGS

Blood examination—Total leucocyte count did not show more than 7,640 per cmm. except in 3 cases where it rose up to 11,040 per cmm as these cases showed secondary pyogenic infections.

Differential count—In most cases differential count showed an increase of polymorphonuclear cells, i.e. 60 to 80 per cent in some cases. I expected an increase in eosinophiles but I could not get more than 5 per cent in bad cases—except in 2 cases—who were having attacks of 'asthma' and the counts were 11 per cent and 18 per cent.

In 4 cases Kahn's Test was moderately positive.

Urine Examination—Amongst the children out of 8, 2 cases showed traces of albumin. Amongst the adults, 11 cases showed urates, and 14 cases both urates and uric acid crystals. In 2 cases sugar and phosphates were present.

Stool Examination—Amongst the children giardia cysts were present in 4 cases and in 3 out of these 4 cases Entamoeba histolytica cysts were also present. In 2 cases ascariis lumbricoidea were present and the remaining 2 were free from any other abnormality.

Amongst the adults out of 42 cases 17 had Entamoeba histolytica either in cystic or vegetative forms or in some cases both. Giardia cysts were found in 4 cases and in 2 trichomonas intestinalis in large number and Hymenolopsis diminuta were available. Ova of ankylostoma duodenale in fair number only were seen in 3 specimens.



**Cultural Examination**—In 9 samples the MacConkey's neutral red lactose agar plates showed the growth of various non-lactose fermenting bacilli and most of them were of the Flexner type. Out of these 9 cases, 2 were of mixed infection being associated with amoebiasis.

Hence it shows that 40 per cent of chronic eczema cases do suffer from *Ent histolytica* infection, 16 per cent from chronic bacillary dysentery, 8 per cent from giardiasis, and about 6 per cent from various helminthic infection, mostly by ankylostomiasis.

#### TREATMENT

With all these findings and examinations, the production of eczema may be regarded as due to a combination of two factors, internal and external and as such there should be two main lines in the treatment—

(a) Protection against external condition combined with the application of medicines designed to exert an active curative influence. Here is a case note where external protection alone cured the condition.

Sonkhi, 32, Hindu, male, with lesions on the back of the forearms, relapsing every summer for the last 5 years. Family history—nothing particular. Stool examination showed a few *Ent. histolytica* cysts. He, being a postal peon, had to remain under hot sun for about 4 hours daily, and every year with the onset of summer he used to get a fresh attack. On medical advice, his duties were changed from outdoor to indoor works and he was soon cured.

(b) An internal mode of approach designed to remove the sensitizing factor, whatever it may be. When there is a septic focus or any defect is found, it should be dealt with. In cases under my care, only external treatment brings a rapid cure, but they are temporary. I doubt an effective cure unless and until the sensitizing factor is detected and removed.

For practical purposes chronic eczema may be grouped into two types—moist and dry.

*For chronic moist type* which is very common, external application of ½ per cent silver nitrate solution, soaked in gauze every 4 hours for 2 days will lessen the oozing of serum and itching as well. This is followed by application of gentian violet lotion (gentian violet 30 grains, absolute alcohol 1½ drachm, distilled water upto 1 ounce) morning and night for a few days till the lesions are dry.

Few obstinate cases of moist type were also treated with compound sulphur lotion with good results.

*Internally*—Bowels are kept open by mild purgatives and errors of diet where found are corrected. Glucose drink and alkaline mixture with potassium bromide is prescribed in severe cases to relieve itching at night.

*Protein shock*—Both injections of milk and auto haemotherapy were tried in groups of cases, but I found auto haemotherapy, from 2 c.c. ranging up to 10 c.c. increasing the dose by 1 c.c.—twice a week, was far more effective and uniformly tolerated by all patients. Care should be taken to wash the syringe with sterile warm saline before drawing the blood from the vein.

*For chronic dry scaly type* treatment is very disappointing. After cleaning the part with absolute alcohol, application of Whitfield's ointment combined with liquor carbon detergens, i.e., (acid salicylic 15 grains, acid benzoic 15 grains, cocoanut oil 4 drachms, liquor carbon detergens ½ drachm and vaseline 4 drachms) gave encouraging results. Where there was excessive itching present, acid carbolic may be added to the ointment.

*Internally*—Liquor arsenicalis et hydrargyri iodide 10 minims, mag sulph., ½ drachm, aqua menth pip upto one ounce, should be given thrice daily after food.

*Injection*—Injections of pentavalent compound of arsenic in low doses always gave very good results in dry forms. Almost always after the 3rd or 4th injection the symptoms subside and there is a marked improvement of the lesions. For this purpose Acetylarsen (M & B) 2 c.c. for children or 3 c.c. for adults injected intramuscularly twice a week, gave very satisfactory results.

In one series of cases Thiosarmine (Brahmachari) from doses 0.75 gm. to 45 gm twice a week were tried with good results. Average total of 1.5 gm of Thiosarmine were required per case.

In 1941 a series of 5 very obstinate cases of chronic type were treated alternatively with injections of liver extract and Thiarsin (B C P W) with a course of 9 injections of each. All of them were cured and are still free from a recurrence.

In another series of 4 cases injections of liver were tried together with external application of modified Whitfield's ointment. The lesions gradually cleared up but it took a long time and unfortunately one of them had recently a relapse with acute symptoms.

In one case of 22 years' standing where all treatment failed to stop the frequent relapse, 9 weekly injections of gold, Solganal "B" oleosum, were given. After the 6th injection patches of both hands disappeared. It is interesting to note that he is free from the relapse uptill now.

In very obstinate cases of chronic type gold preparations are worth trying.

In another series of 5 cases, short exposures of X-rays at intervals of 5 days combined with external treatment gave very rapid result but did not stop the recurrence in 3 cases. X-ray exposures are very good where rapid cure is wanted.

#### COURSE OF THE DISEASE

It is very difficult to arrive at a definite conclusion regarding the recovery rate from such a small series of 50 cases. Out of 50, only 21 cases, i.e. 42 per cent were clinically cured. 2 died from other diseases, 7 cases left the place and the remaining 20 cases, i.e., 40 per cent are still having periodical relapses.

#### COMMENT

Hard and fast lines of treatment are not at all possible in treating chronic eczema cases and as regards drugs there are none which act like specific.

Each case, according to its history stage of the disease and laboratory findings has to be treated differently. Success in the treatment of eczema requires patience alike on the part of the sufferer and the physician.

Modification and changes in the treatment are sometimes needed according to the changes in the lesions. But changes should never be made except for good reasons and after giving a particular medicine a fair trial. It is not difficult to cure a case of chronic eczema but to prevent its recurrence is the most difficult problem.

#### ACKNOWLEDGMENT

I take the opportunity to thank the Chief Medical Officer, Capt B. Jha, for encouraging me to study the cases and for providing me with all the facilities from the hospital.

## SYMPOSIUM ON TREATMENT OF ACUTE APPENDICITIS

At the Scientific Section of the XX All-India Medical Conference at Ahmedabad in December 1943 last, Dr R P Dalal, F.R.C.S (ENG) of Ahmedabad in opening the discussion said

I have chosen the subject of to-day's discussion on the treatment of acute appendicitis, because I feel that there is considerable confusion in the minds of general practitioners as to what they should advise their patients when they come across a patient with pain in the appendicular region, and when they suspect appendicitis in these cases. Patients in this part of the country are not always willing to get operated, as in western countries and always are unwilling to consult a surgeon, in the beginning. Naturally they have hopes to get cured by medicine, and consult a physician who always advises him conservative treatment except in advanced cases.

I do not intend to discuss signs and symptoms of appendicitis. The typical symptoms of appendicitis are well known. It is the duty of the attending doctor to examine the patients thoroughly and if he has the slightest reason to suspect appendicitis, not to give a purgative to relieve constipation and morphia to relieve pain. If constipation is suspected it is desirable that an enema should be given and the patient should be confined to bed. An immediate consultation with a surgeon is indicated in all suspected cases.

Treatment of appendicitis is always surgical. In hospital practice, the cases should always be admitted in surgical wards. Even if conservative treatment is to be followed for those who refuse operation, they should be under observation of a surgeon because he is the best man to decide when operation is imperative. Many lives are lost by temporising. Temporising is unsafe in children as appendix may perforate in early stage, in old people, and in women after labour where resistance to infection is much below normal. There is no medical treatment of appendicitis. There are medicines which may alley pain but none to control the course of disease.

Amongst surgeons there are two schools of thought. One school advises conservative treatment described by Oschner and Scheren in all cases and operate in quiescent stage.

If operation is done in quiescent stage, the recovery is uneventful and operative mortality very low, because the patient can be well prepared for operation and his vitality may not be low by starvation, temperature, etc. I do not agree thoroughly with this method of treatment though I follow it in some cases in modified form.

The other school advocates radical treatment—operate in all cases as soon as diagnosis of appendicitis is made or even if appendicitis is suspected. The sooner the better if possible within first 12 hours.

As I told you, very few patients are referred to a surgeon within first 12 hours and even if the patient is seen within that period he may not be willing to undergo an operation without consulting his relative and that and later he may be seen with some complications.

On the other hand some surgeons at once run to diagnosis of appendicitis in any and every case of abdominal pain especially when it is in right lower abdomen. My belief is that we are doing too much in these cases to lose respect of patients as many of these patients who refuse operation never need operation after the first attack of pain—in others the abdominal pain remains after the appendix is removed and

they always complain that in spite of operation they are not relieved of the complaint.

This group of surgeons argue that they do not know when the appendix may get gangrenous, may perforate and form an abscess and other complications—so why not operate as soon as patient with appendicular trouble is seen. After all what does it matter if the appendix is there in the body or not? I used to operate in these early cases and on exploration found appendix quite normal and I feel that many of these were operated unnecessarily.

My objection in advising immediate operation in all stages seen at any time are—

In some cases we unnecessarily operate as the diagnosis may be mistaken. About 50 per cent of cases with appendicular pain treated on conservative lines did not require operation, at all. The uncalled for laparotomy not only weakens abdominal wall and cause ventral hernia, but may result in other post-operative complications as formation of peritoneal bands and adhesion leading to intestinal obstruction. The operation is much more risky and difficult in advanced stage with chances of breaking down the adhesion and leading to generalised peritonitis. If drainage is required there are chances of ventral hernia, peritoneal adhesion and faecal fistula which gives lot of trouble to the patient and keeps him invalid for a long time.

I do not advocate upto the word either of these schools. I believe cases must be considered on their own merits in stages in which they are seen by the surgeon.

In the present stage of my experience I classify appendicitis for sake of treatment as follows:

1. Simple appendicitis—Here the inflammation is limited to appendix alone. There is little or no inflammation of peritoneal coat and none of peritoneal cavity. This type gives rise to symptoms of appendicitis which are mild. The pain in the abdomen localises in right iliac region with tendency to nausea, tenderness in appendicular region, without rigidity, rise of temperature upto 99 or 100°. Pain is more marked when the patient is constipated and the caecum full of faeces. In these cases the attack subsides in a day or two but may recur.

I prefer to keep these patients in bed with water or glucose water by mouth and inject sulphonamide to combat infection. Majority of these get relief in two or three days and like to walk out of the hospital on the 4th day. These cases may be operated in quiescent period when their vitality may be at maximum.

2. The second variety is one giving rise to colic pain due to obstruction in the lumen of the appendix either due to an attack of inflammation or the presence of a foreign body in the lumen of appendix. They are rarely attended with rise of temperature as there is no inflammation but the appendix is tender during the attack and a pencil like swelling can be felt. These attacks are considered bilious attacks. The pain is not limited to right iliac region but may be epigastric, umbilical and, therefore, mistaken for intestinal or biliary colics.

In many of these cases the pain interferes with enjoyment of food and exercise. These cases do not require immediate operation, but can be operated in the quiescent stage when the appendix is found kinked or there is obstruction in lumen by faecolith or any other foreign body.

3. The third variety I would like to call acute fulminating type. In this variety the inflammatory attack is always severe from the onset giving rise to symptoms which are well marked from the beginning of the attack.

The abdominal pain is severe from the beginning which localises to the right iliac region. Tenderness and rigidity is well marked and the temperature rises to 102°-103° F in first 12 hours. The pulse is rapid, the patient is restless with pain, and vomiting which is frequent and soon gets exhausted. These are the cases which are liable to get complications, and require immediate operative interference.

4 The fourth variety is the condition when patient is seen with a lump in the right iliac region which may be due to adhesion round the appendix or localized abscess.

These cases come with the history of the appendicular attack 3—5 days before, which they neglected and gradually a lump appeared in the region giving rise to pain, which is persistent, though not severe as before, after the lump is formed there may not be any vomiting, etc.

Blood count shows marked leucocytosis. One would prefer to keep these cases under observation in surgical wards of the hospital or in a nursing home where they can be under direct observation of a surgeon who can decide to operate at any stage if the patient is not progressing favourably.

Patient is confined to bed in Fowler's position, nothing is given by mouth except water and glucose water, no purgative and no enema. The pulse, temperature, respiration are noted hourly, and the size of the lump is marked out by skin pencil. To increase resistance and overcome infection, injection of Orargol is given daily until the lump disappears. Orargol is a preparation containing colloidal gold and silver. It acts by increasing the leucocytes in the blood.

In some of these cases, the lump decreases marvellously. I have tried injection of sulphonamide group of drugs in a good number of cases with favourable results. If during the course of observation the lump does not get smaller day by day or, increase in size, the symptoms increase in severity giving rise to increase in temperature and rapid pulse, and the pain becomes persisting, operative interference is indicated. The abscess is opened and drained and the appendix if found easily without interfering with adhesion, removed. In favourable cases the lump disappears and the patient is advised operation in quiescent stage when convalescence may not be prolonged and patients may not get post-operative complications.

5 The last variety is when patient is seen with generalised peritonitis.

This is a condition resulting from neglected cases of acute fulminating variety, when purgative is given or when the abdomen is massaged to reduce the lump. This condition is associated with severe pain, well-marked rigidity of the lower abdomen, vomiting, distention and other symptoms of paralytic ileus. When the peritoneum is infected, sooner the operation is performed the better, for the early removal of the source of infection and extravasation always helps to arrest the spread of the disease.

To sum up, I do not believe that appendix deserves removal as frequently as is done now-a-days. About 50 per cent of cases do not require operation at all. I would advocate radical operation during the attack in only acute fulminating variety with or without a lump and in cases of peritonitis.

Operation in quiescent stage in mild cases, in appendicular colic, and with lump which subsides by conservative treatment is the treatment of choice.

I am fully aware that there will be considerable controversy in discussion to follow as to when the cases of acute appendicitis should be operated upon.

TABLE SHOWING THE RESULT OF 51 CASES OF ACUTE APPENDICITIS TREATED WITHIN LAST 2 YEARS

	No of cases	Mortality
Treated on conservative lines Cases seen with mild attack, duration of pain from 6 hours to 4 days (Out of these 15 were operated in the quiescent stage, all made uneventful recovery)	28	Nil
Operated within first 48 hours Cases of acute fulminating type with rise of temperature, vomiting, severe abdominal pain and localised rigidity (One who died had gangrenous appendix)	14	1
With generalised peritonitis Operated, appendix removed, abdominal cavity drained (One who died had peritonitis of 3 days)	3	1
Localized abscess formation Abscess incised and drained (Out of these the appendices were removed in 3 patients in the second stage)	6	Nil
Total	51	2

I have given my own views on the subject and the line of treatment which I follow for the last few years after trying both methods of treatment and my mortality rate is less than that of the radical school as will be seen from the table above.

\* \* \* \* \*

The following doctors took part in the discussion

Dr P P Sheth, Dr D D Variava, Dr M D Patel (Ahmedabad), Dr M K Parikh (Ludhiana), Dr N R. Desai (Ahmedabad) and Dr Dudha (Bombay)

\* \* \* \* \*

Dr P P Sheth said that he was for the radical method and would operate on a case as soon as appendicitis was diagnosed. The exact pathological condition of the appendix could not be made out clinically and in order to avoid patients' time and money he was always for immediate operation except in cases with a lump.

\* \* \* \* \*

Dr Variava supported the opener of the discussion in conservative method of treatment and strongly objected to massaging the abdomen in case of a lump with pain.

\* \* \* \* \*

Dr M D Patel, F.R.C.S (Eng), commented that the disease was definitely on the increase as compared to some years ago, whatever the cause might be. He said,

"There are bound to be differences of opinion regarding the time of operation as the experience of the surgeon varies. There cannot be any set rule. However, I will like to remove the appendix as far as possible if the condition of the patient and the circumstances permit. The peritonitis once it starts is serious. The mortality of the abscess is 7 per cent as a whole. There are two types of organism in appendicular abscess, one in which B. Coli predominates and the other in which B. Welchii and other organisms causing gas gangrene predominate. The latter cases are far more serious than the first.

(Continued at foot of col 1, page 25)

# JOURNAL OF THE INDIAN MEDICAL ASSOCIATION

CALCUTTA, NOVEMBER, 1944

## HAEMOGLOBINOMETRY

No other single examination in clinical medicine is being more used and abused than haemoglobinometry. To-day determination of haemoglobin of blood has become essential in many diseases. With the growth of biochemistry and precise knowledge of nutrition, the chemistry of haemoglobin has been studied in more details. And much controversy has appeared under this heading in medical journals. But no unanimity has been arrived at nor a meeting has taken place in this country as yet to come to some conclusion regarding standardisation or to clear up the confusion prevalent in the subject. In England, the Medical Research Council appointed a committee to investigate "traumatic shock". This body found to their dismay that their progress was checked by the "lack of uniformity of method for estimating the various constituents of the blood". They appointed a subcommittee to report on the subject after proper investigation. This report has been published in the *British Medical Journal*<sup>1</sup>.

Difficulty of rational haemoglobinometry starts with the normals. What is hundred per cent haemoglobin? Is it 13.8 gm., 17.2 gm., or 12.4 gm. per 100 c.c.? Which figure should be taken as normal? Determination of normals is also not an easy affair. Who is a normal? A healthy male, going about his usual duties? But quite a large number of people improve in their haematological values after taking iron, iodine (thyroid), liver extract, vitamin B-complex and other adjuvants of haemopoiesis. Hence random sampling of blood will not help us much to establish a standard for haematological work. This seems to be the defect of the investigators in our country too, as selection of normals is not controlled. It is not determined whether their blood condition could further be improved by adjuvants. Sahli considered that only highest value obtainable in a locality should be established as a "norm" and that is the reason why he selected 'strongest assistants' to establish his standard of 17.2 gm per 100 c.c. of blood, and he kept a margin of 20% either way as the limit for normality. American authors prefer normals for each laboratory and they insist on finding out the normals before setting up of laboratory percentage. Hence the technician must represent the normal. A decision on this point has not yet been arrived at.

The second confusion lies in the selection of haemoglobinometers. For practical purposes a haemoglobinometer must be portable, easy of manipulation, accurate. And many pros and cons have been discussed for each instrument. Take the various types only. There are altogether five methods for haemoglobin determination: (a) B<sub>2</sub> gas analysis, which measures oxygen capacity of the blood, (b) Colorimetric methods, where the colour of the blood, after treating with chemicals, is matched against coloured standards either coloured liquid or plates, (c) Photoelectric methods, (d) Photo-electric methods, where the amount of light that passes through the solution is estimated, (e) Method for estimating the iron content of well-

washed lysed red cells. Of these, colorimetric method is commonly used. The most common ones in use in this country are types of Sahli, Hellige, Haldane. Which one is perfect? The solution of Sahli's standard fades with age, the solid particles are precipitated down. Hellige's coloured prisms do not keep their colour indefinitely, though some workers assured us to the contrary, again, carrying coal-gas to the bedside is not very practicable. The Medical Research Council of Great Britain has standardised the Haldane-Gowers haemoglobinometer, and recommends the use of the standardised instrument. But this is not available in this country.

While generally condemned by the clinical pathologists, hematologists like Whitby and Britton mentioned the Tallquist method of haemoglobin value determination. This has been recommended by Hay<sup>2</sup> recently. Hay says, "The easiest haemoglobinometer to use was the Tallquist, which should be of the Helsingfors type and not a copy of it. Much of the scorn which has been directed against the Tallquist measures seems quite undeserved. It has received recommendation from Peters and Van Slyke, and Senti. The Tallquist also permits of a direct comparison of the patient's blood with one's own blood, and provides a permanent blood record of the case. Though it is very difficult to see eye to eye with Hay, it leaves no doubt in one's mind that Tallquist demands a better comparative treatment."

In this way if we take up each instrument in detail difficulties multiply, it is not yet decided how many minutes are required for complete conversion of haemoglobin into acid haematin and so on.

Hence the time is ripe, when the clinical pathologists should meet and clear up the different points so that haemoglobinometry might be placed on firmer footing.

## POSITION OF HEAVY CHEMICALS IN INDIA AND GOVERNMENT POLICY

The Committee of the Indian Chemical Manufacturers Association have taken a lead in the right direction with regard to the Government policy as adopted towards the manufacture of heavy chemicals in this country. The only way to improve India's appalling low economic position lies in the industrialisation of the country. The part played by heavy chemicals in any industrial reorganisation need not be stressed, yet the policy adopted by the Government is curious. In every country the State comes forward to subsidise everything concerned with the development of indigenous industries. But it is not so in India. The Indian Chemical Manufacturers Association has pointed out that certain essential chemicals like alumina, ferric, magnesium sulphate, sodium sulphide, sodium thiosulphate, zinc chloride, soda ash, calcium chloride and bichromates are manufactured on a scale which remains unutilised but the Government is encouraging imports of these from other countries. This policy can hardly be commensurate with self preservation. The present war has amply proved that every country should try its best to be self-sufficient as much as possible. Thousands of Indian lives are being lost at the present moment for want of supply of medical requirements for which we are to depend on imports. We strongly urge the Government to take into account the weighty arguments of the Indian Chemical Manufacturers Association and revise their unjustifiable policy that is being followed with regard to the indigenous heavy chemical industry of India.

<sup>1</sup> Report—*Brit M J* 1 209 1943

<sup>2</sup> Hay, J—*Fairbairn M J* 50 626 1943

articular cartilage covered by a fine synovial membrane. Henle described a delicate layer of cells (perichondrium) upon the actual free surface of the articular cartilage. Davis, Strangeways, Timbrell Fisher, and others, however, have confirmed the fact that in the main part there is no membrane on the articular cartilage.

In conclusion, it is generally believed that in the adult the lateral area of the articular cartilage is covered with a delicate extension of the synovial membrane; the central area, on the other hand, is completely deficient in any membrane or epithelial layer.

Whence, then, does articular cartilage derive its nutriment?

William Hunter believed that the articular cartilage derives it from the *circulus articuli vasculosus* described by him. Bart stated that in the adult it is principally nourished by fluid exuded from the vessels of the underlying cancellous bone. In adult articular cartilage there can be demonstrated very minute canals, probably for the passage of nutrient fluids that otherwise in this dense tissue would permeate with difficulty. According to Bart, the free surface of the cartilage is nourished by *liquor sanguinis* exuded from the *circulus articuli vasculosus*.

Leidy held the view that, during development and growth, articular cartilage possesses an interstitial nutrition; but that, after the cartilage is fully formed, it is supplied by fluid that osmoses from the vessels beneath its attached surface, and from the *circulus vasculosus* at its circumference, and especially by the synovia upon its free surface; he stated that the synovia is particularly rich in albumin. By experiments on calves, rabbits, and pigeons he found that the articular cartilage is quite capable of imbibing the synovial fluid. Toynbee considered that the chief supply of pabulum came, in the adult, from lymph exuded from the blood-channels of cancellous spaces. Strangeways observed 'loose bodies' in the joints, and discovered by operation that continued enlargement went on for a long time, although the loose bodies were quite detached; he concluded, therefore, that the synovial fluid is an important source of pabulum. Timbrell Fisher concluded that the deeper strata of the articular cartilage are nourished in the manner described by Toynbee, that the central articular area is supplied by the synovial fluid, and that the remainder near the edges receives its nutrient supply from the *circulus articuli vasculosus*. Using Shattock's method of staining mucin pink with carbol-thionin, Timbrell Fisher demonstrated that the zone of matrix of articular cartilage immediately surrounding each cell group is stained pink, and that the pink zones branch and intercommunicate. He considered, therefore, that the articular cartilage receives nourishment from plasma percolating through the network formed by the more mucinous part of the cartilage matrix that surrounds the cell groups.

#### EXPERIMENTS.

My own experiments, made under the guidance of Mr. Choyce in the Surgical Unit at University College Hospital, are as follows:—

Using rats or rabbits, I opened the knee-joint by an external longitudinal incision, and then removed from the condylar surface of the femur, where

the cartilage is uncovered by any membrane, either one or two pieces of articular cartilage, some with and some without portions of subjacent bone. I then left the detached piece or pieces free in the same joint cavity, and closed the joint by suturing the capsule and skin with human hair which had been sterilized by boiling in water. For comparison, in some cases a piece of bone taken from the tail of the same animal was substituted for the detached cartilage, and the latter was auto-transplanted into the subcutaneous tissue of the animal's back.

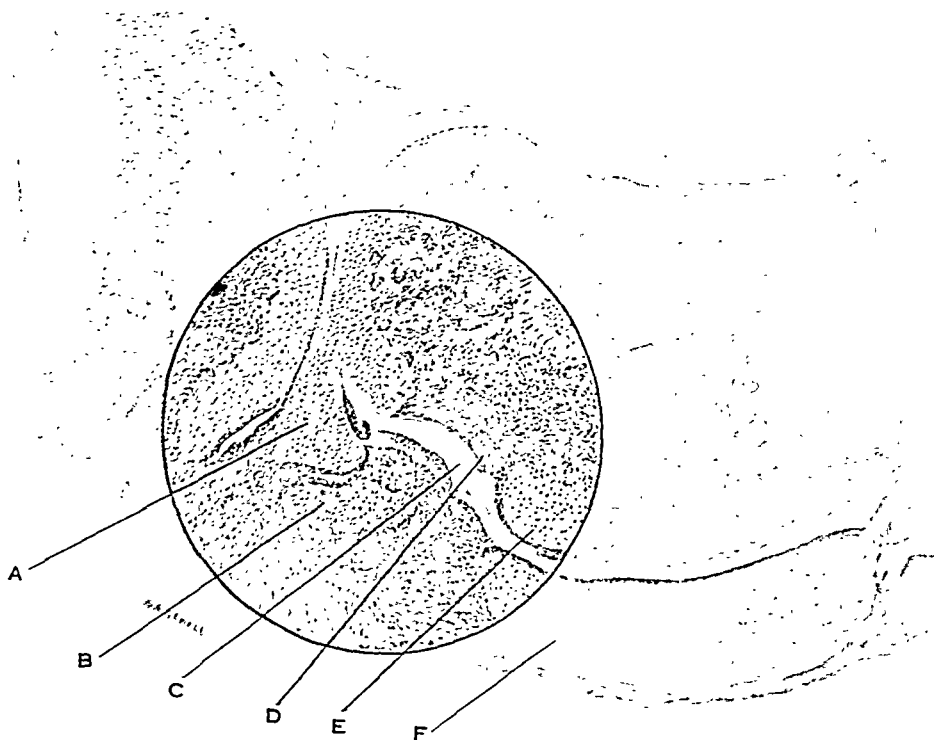


FIG. 25.—(Experiment 35). Examination 11 days after operation. A, Intra-articular cartilage; B, Loose body; C, Joint cavity; D, Defect of articular cartilage; E, Articular cartilage (original); F, Patella.

In another series of experiments a fresh whole knee-joint was transplanted into another animal of the same species; in still another a caudal vertebra together with its neighbouring joint was transplanted into the animal's back. The results of these control experiments will be reported later.

The results were observed after intervals that varied from one to fifteen weeks. The rats used were mostly young, or young adults, and approximately of the same age. Each specimen was fixed in 10 per cent solution of formaldehyde or Zenker's solution, decalcified in 5 per cent solution of nitric acid, followed by 1 per cent solution of sodium carbonate, and then thoroughly washed in running water. It was then embedded in paraffin

or celloidin and stained with Mallory's eosin-methylene-blue or alum-haematoxylin-eosin.

Only a few of the typical results are here described :—

I. EXPERIMENT NO. 35.—Rat : age 45 days, male.

*Method.*—Rigid asepsis. Ether anaesthesia. Piece of articular cartilage detached from condylar surface of femur and left free in the joint cavity.

*Examination 11 Days after Operation.*—The detached cartilage was found in the synovial membrane between the anterior end of the intra-articular cartilage and

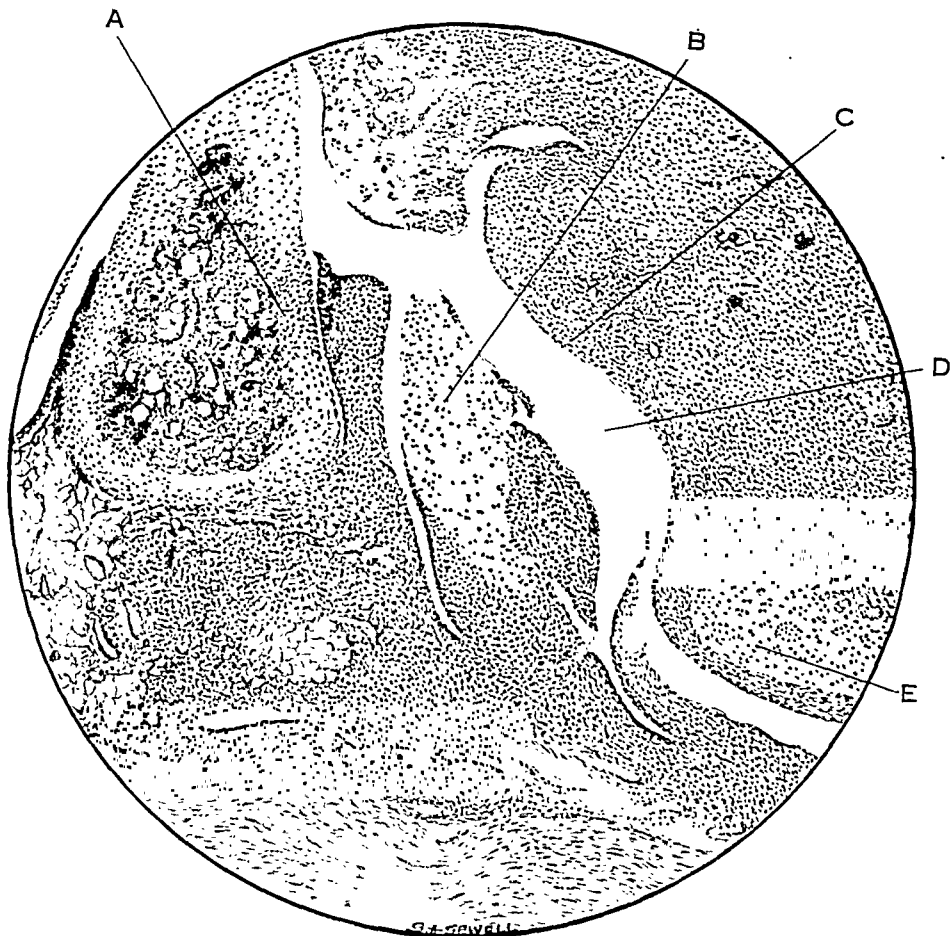


FIG. 26.—(Experiment 15). Examination 3 weeks after operation. A, Intra-articular cartilage; B, Loose body; C, Defect of articular cartilage; D, Joint cavity; E, Newly-formed cartilage.

the patella. It had become entirely surrounded by fibrous tissue, and the cartilage-cells had retained vitality, for they stained fairly well. No proliferative activity was seen. In this case no bone tissue had been detached. The defect on the condylar surface, caused by removal of the piece of cartilage, was found to have become lined with a layer of fibrous tissue, which intruded, more or less, into the bone-marrow. The bony tissue just below this fibrous tissue had lost activity, the bone-cells staining either badly or not at all. (*Fig. 25.*)

II. EXPERIMENT No. 15.—Rat : adult, male.

*Method.*—As in No. I, but with the detachment of some bone with the fragment.

*Examination 3 Weeks after Operation.*—The piece of cartilage was found partly wrapped in synovial membrane, and lying between the patella and the anterior part of the intra-articular cartilage ; nearly half of it faced the joint cavity, and was free from covering membrane. The cartilage-cells in it stained well, but no bone-cells could be found, alive or dead. The cartilage defect in the femur was abundantly covered with fibrous tissue which contained many newly-formed blood-vessels ; some fibroblasts were also seen scattered in the bone-marrow. In this fibrous tissue there was an area of newly-formed cartilaginous tissue. In the bony tissue around the injured area a little of the bone had lost its bone-cells. (Fig. 26.)

III. EXPERIMENT No. 31.—Rat : very young female.

*Method.*—As in No. II.

*Examination 6 Weeks after Operation (Fig. 27).*—In this case a detached piece of cartilage was found in connective tissue in the anterior part of the joint, near the patella. Not only had the original cartilage retained its vitality, but newly-formed cartilage could be seen. On the other hand, the bone-cells that had been detached with the cartilage had disappeared. The defect in the femoral cartilage was mostly covered with fibrous tissue, but in part with a tissue intermediate between cartilage and fibrous tissue, and to a small extent with a newly-formed cartilaginous tissue.



FIG. 27.—(Experiment 31). Examination 6 weeks after operation. A, Loose piece of cartilage in joint, near patella.

IV. EXPERIMENT No. 24.—Rat : young female.

*Method.*—As in No. II.

*Microscopical Examination 7 Weeks after Operation.*—The detached fragment

was found half covered with synovial membrane, and half projected, uncovered, into the joint cavity. Both bone and cartilage-cells in it stained well. The femoral defect was repaired, in some part with newly-formed cartilage and in part with fibrous tissue ; moreover, some tissue, transitional between cartilage and fibrous tissue, was seen. (Fig. 28.)

V. EXPERIMENT No. 23.—Rat : adult female.

*Method.*—As in No. II.

*Microscopical Examination 8 Weeks after Operation (Fig. 29).*—A fragment was located in the synovial membrane, partly attached to it and partly projecting free into the articular cavity. The cartilage-cells stained well : the original bone-cells had disappeared, but a slight new formation of bone-tissue could be found. The femoral defect was covered with a tissue that was mostly homogeneous, and no newly-formed cartilage could be seen.

VI. EXPERIMENT No. 18.—Rat : young male.

*Method.*—As in No. II.

*Microscopical Examination 12 Weeks after Operation (Fig. 30).*—The detached fragment was slightly surrounded with fibrous and fatty tissue derived from the synovial membrane, and lay just under the patella. The cartilage-cells in it showed staining activity fairly well, but their proliferative activity was doubtful. The



femoral defect was covered with a thin layer of fibrous tissue, directly covering the subjacent bone ; no cartilage could be seen in it.

VII. EXPERIMENT NO. 20.—Rat : adult female.

*Method.*—As in No. II. This rat gave birth after operation.

*Microscopical Examination 13 Weeks after Operation (Fig. 31).*—The detached fragment was found in the popliteal part of the joint ; it had become pedunculated

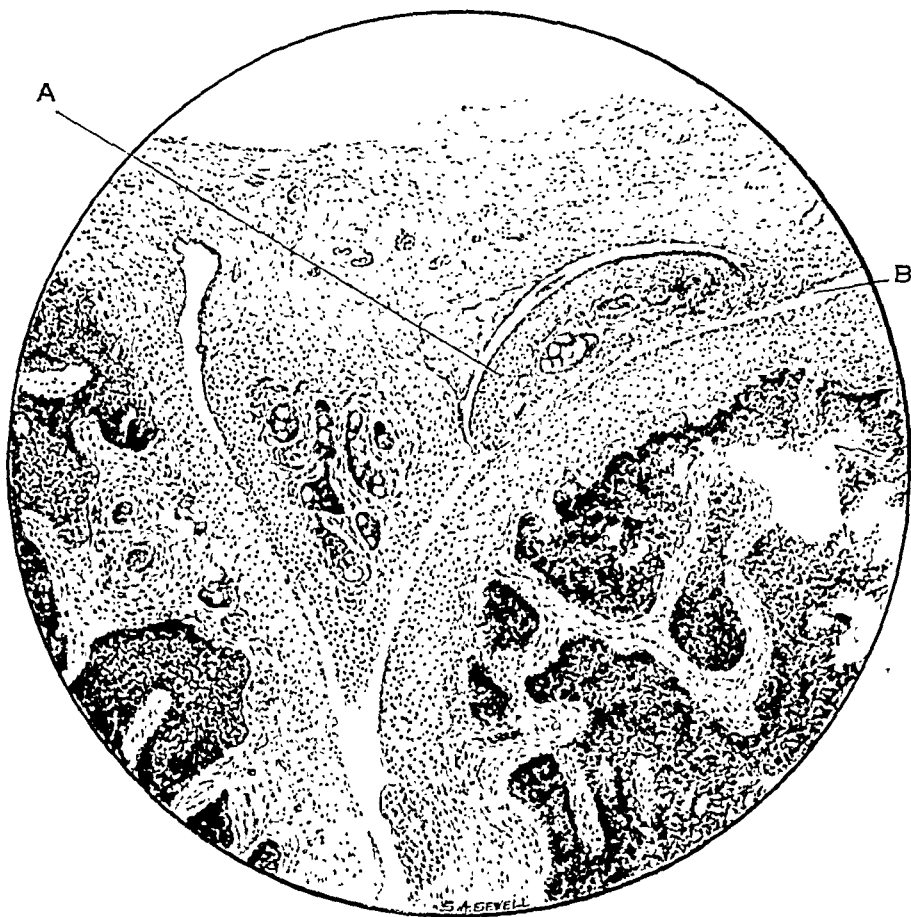


FIG. 28.—(Experiment 24). Examination 7 weeks after operation.  
A, Loose body ; B, Joint cavity:

to the synovial membrane, and its whole mass had become covered with one or two layers of fibrous-tissue cells. Both cartilage-cells and bone-cells in the fragment stained well, though they were quite slight. The femoral defect was repaired with homogeneous tissue, newly-formed cartilage, and fibrous tissue.

VIII. EXPERIMENT NO. 34.—Rabbit : young male.

*Method.*—As in No. II. Two pieces were detached.

*Gross Finding 4 Weeks after Operation.*—On opening the joint, two fragments were found. One was free in the joint cavity, the other was completely wrapped in synovial membrane. The former was smoothly rounded, almost oval-shaped,

and of the size of a rice grain ; the latter had maintained its original irregular form. A few drops of synovial fluid escaped ; in appearance it was indistinguishable from that of the healthy side. The defect in the articular cartilage of the femur showed piling up with a whitish, dense mass ; no adhesion was found.



FIG. 29.—(*Experiment 23*). Examination 8 weeks after operation. A, Joint cavity ; B, Interarticular cartilage ; C, Loose body in synovial membrane.

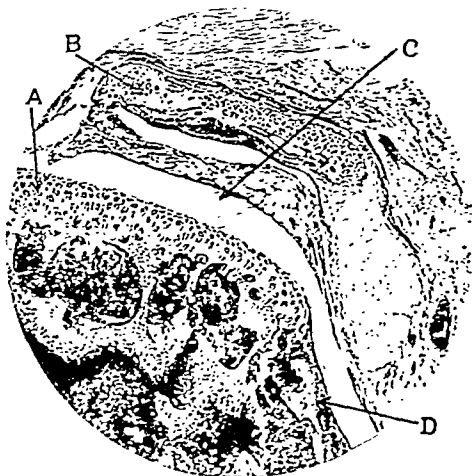


FIG. 30.—(*Experiment 18*). Examination 12 weeks after operation. A, Articular cartilage (original) ; B, Loose body ; C, Joint cavity ; D, Defect of articular cartilage.

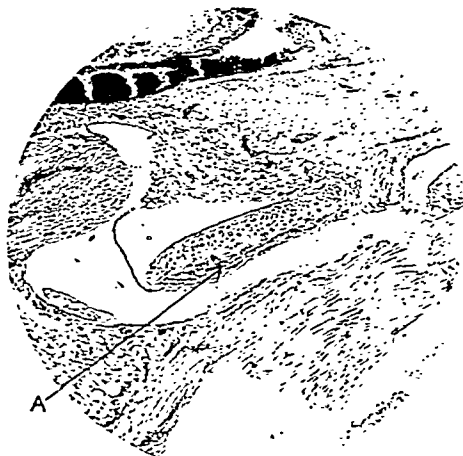


FIG. 31.—(*Experiment 20*). Examination 13 weeks after operation. A, Loose body.

## Microscopical Examination (Figs 32–35).—

a. The fragment that was free in the joint : this was covered with thin layers of fibrous tissue. The original cartilage had maintained itself, but in certain places the cartilage-cells stained feebly and were of lowered vitality, and also there was well-marked new cartilage proliferation. The old bone-tissue had nearly lost its

bone-cells, but slight new bone-formation could be seen. The bone-marrow consisted mostly of fatty cells and red blood-corpuscles.

*b.* The fragment that had gained an attachment to synovial membrane: this was completely buried in the synovial membrane. In it the newly-formed bone-tissue was rather abundant, and the old bone, which had lost its bone-cells, was in small amount. The cartilage-cells stained well, but no evidence of new proliferation could be found. A small mass of dead bone, isolated from the above fragment, was detected in the fibrous tissue. The defect in the femur was repaired with the following structures: the superficial layer consisted of strongly developed fibrous tissue cells; the middle zone of tissue transitional between fibrous tissue and cartilage; and the deepest layer, in contact with the subjacent bone, was composed of

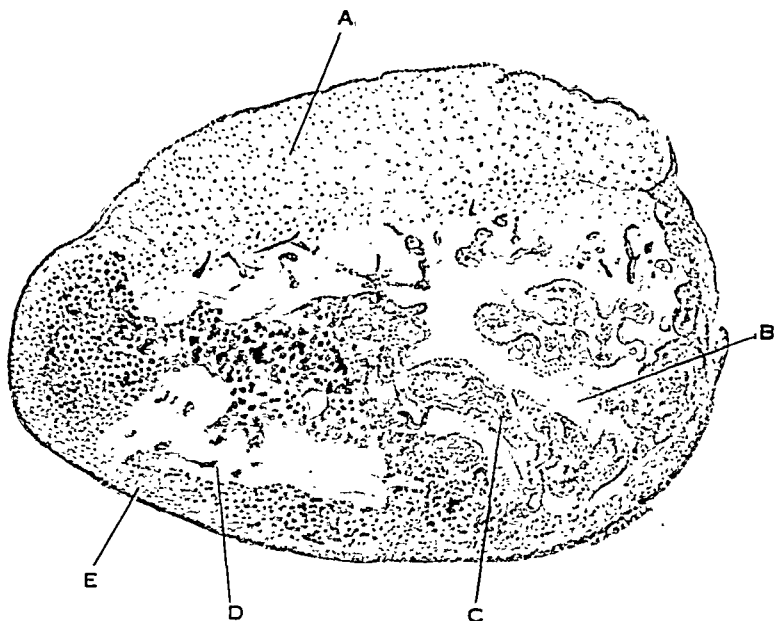


FIG. 32.—(*Experiment 34*). Young male rabbit: the completely detached loose body, 4 weeks after operation. A, Original articular cartilage; B, Newly-formed bone; C, Bone-marrow; D, Dead bone; E, Newly-formed cartilage.

newly-formed cartilage-cells. The bone-tissue just below the above structure showed proliferative activity better than in any other part. The whole repaired zone, at its greatest thickness, was nearly four times thicker than the surrounding undamaged articular cartilage.

#### SUMMARY OF ALL THE EXPERIMENTS, INCLUDING THOSE NOT DESCRIBED HERE.

**Microscopical Examination.**—The cartilage-cells in the loose bodies mostly retained vitality, and many proliferated; the bone-cells, on the contrary, became inactive and died; this agreed with Timbrell Fisher's results, and I believe that cartilage tissue is always more persistent than bone-tissue. After four weeks, however, newly-formed bone-tissue appeared round the dead bone in the loose bodies; this finding is confirmed by other experiments in which I transplanted pieces of the tails of rats, including bone and cartilage, into

animals' backs, and showed that, in almost all cases, new bone appeared after two weeks. As was expected, proliferative activity appeared greater in the younger than in the older animals.

With one exception the loose bodies were found to have gained a definite

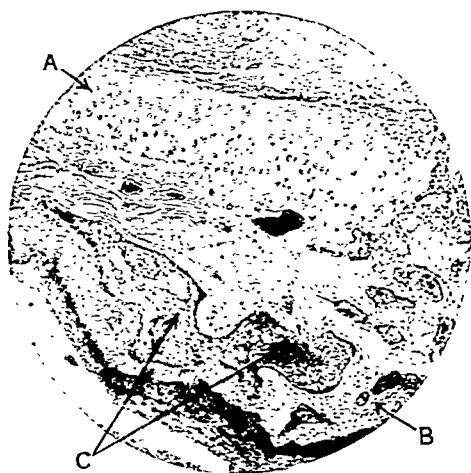


FIG. 33.—(*Experiment 34*). Examination 4 weeks after operation. A, Articular cartilage (original); B, Newly-formed bone; C, Bone-marrow.

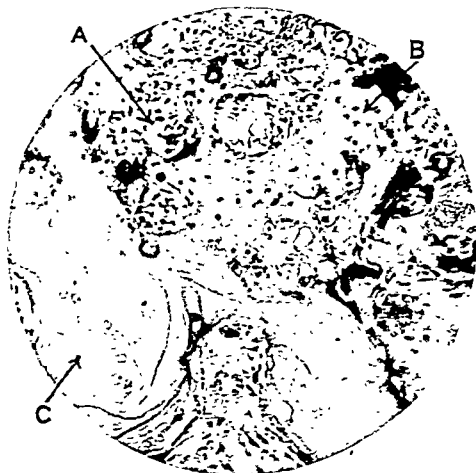


FIG. 34.—(*Experiment 34*). Examination 4 weeks after operation (higher magnification than Fig. 33). A, Bone-marrow; B, Newly-formed bone; C, Dead bone.

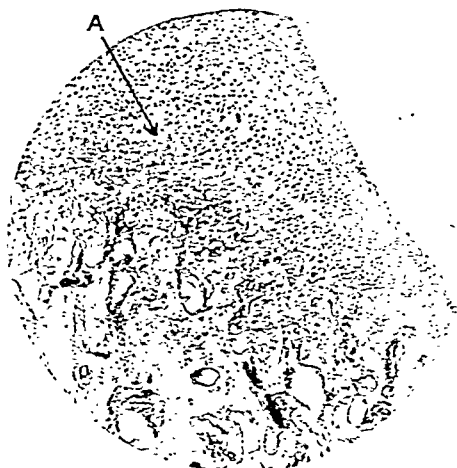


FIG. 35.—(*Experiment 34*). Examination 4 weeks after operation. The defect was filled with tissue and newly-formed cartilage. A, New cartilage.

attachment to the synovial membrane: some were almost embedded in it, others were affixed by edges and the whole of one surface, whilst still others had secured a pedunculated attachment. Some bodies that had been set free in the joint could not afterwards be found even by careful search. In

one case (a rabbit) only was the loose body found wandering free in the joint cavity; it had retained its activity. Most of the 'loose' bodies were found to have localized themselves in the synovial membrane of the anterior part of the joint, under or near the patella; one had become pedunculated in the popliteal space. The free one in the rabbit was particularly interesting, because, if it be assumed that it had remained free all the time between operation and post-mortem, it seems to prove that a piece of cartilage separated from all supply of pabulum except that derived from the synovial fluid can not only live but can proliferate; its bone elements had nearly disappeared, but there was slight new bone-formation; its cartilage had clearly proliferated. The question might justifiably be raised as to whether this loose body had been loose throughout the whole period between operation and post-mortem, or whether, like the others in my series, it had secured an attachment, which in this case had later been lost, so that the body again became loose. But careful examination of this body showed no evidence of any past attachment; its surfaces were uniformly smooth and showed no sign of the remains of a torn pedicle. It is therefore fair to assume that probably no such attachment had existed, or that, even if it had, the secondary separation had not been recent. As the cartilage-cells were quite active and there was some slight rejuvenescence of bone, vitality must have been active right up to the time of the animal's death, in spite of a separation that must have lasted much, if not all, of the time since operation.

Most of the other loose bodies had secured attachments to synovial membrane in the anterior parts of the joint, near the patella, though one was pedunculated in the popliteal space. These anterior parts of the joint are probably backwaters into which the loose body is worked during movements of the joint; in the small animals used, the relatively large loose bodies became jammed into these backwaters, and therefore, becoming motionless, there had an opportunity of securing attachment. If larger animals had been used, the loose bodies could have been cut relatively smaller; such smaller bodies would have had wider range of movements, would have been less liable to become trapped in corners, and would probably have remained free in a greater number of cases; it may be noted that the persistently free loose body was found in the only rabbit used; all the other animals were rats or mice.

The supposition that the completely loose body found in my rabbit had been nourished by the synovial fluid is, I think, a fair one, whether it is supposed that complete detachment had persisted since operation, or whether we believe that there had been a temporary attachment that had ruptured; moreover, it is in agreement with Strangeways' cases. The question whether the fluid was normal or not is not, however, so clear. Neither in my own nor in Strangeways' cases was an analytical comparison made between the synovia of the joint with loose body and its fellow without one. Timbrell Fisher's suggestion is that the loose body may cause sufficient synovitis to enrich the protein content of the synovia. However, the joint mouse in my rabbit was so relatively small and smooth and rounded that it probably caused but little trauma; and the synovia at post-mortem exhibited no difference in quantity, colour, or viscosity from that of the corresponding joint of the other limb; its total quantity was too small for analysis.

My experiment, therefore, is confirmatory of the belief that synovia can nourish loose articular cartilage; it may be presumed, therefore, that it has some nutritive function for unloosened articular cartilage, and that it may be an important factor in the nourishment of the superficies of cartilage near the centre of a joint, far removed from both circulus vasculosus and underlying cancellous bone.

### REPAIR OF ARTICULAR CARTILAGE.

In my experiments the incisions for the removal of the pieces of articular cartilage all went through the thickness of the cartilage. The operative condylar defect so made healed by granulation tissue that became fibrous: this tissue invaded the underlying bone. Sometimes (e.g., *Experiment No. 34*. rabbit) it formed a heaped-up mass more than filling the gap. The tissue filling the gap in this case showed three zones, viz., fibrous on articular face, middle zone of intermediate tissue, and deepest zone of new cartilage cells. In another experiment (*No. 37*) cartilage was very freely formed.

**EXPERIMENT No. 37.**—Rat: age 45 days, male. *Method.*—Knee-joint opened; piece of articular cartilage, together with a portion of underlying bone, removed from the condylar surface of the femur.

*Examination 4 weeks later (Fig. 36).*—The defect was found to be smoothly filled with a whitish dense mass; there were no adhesions. Microscopic examination showed that the whitish mass largely consisted of newly-formed cartilage, but its surface was covered with fibrous tissue; there was also fibrous tissue between the new and the adjacent original cartilage. This new cartilage also protruded for a short distance into the subjacent bone-marrow; the development of new bone beneath it was insufficient.

To sum up: The gap at first becomes filled with granulation tissue, which becomes fibrous, then fibro-cartilaginous, then cartilaginous. The time required for the formation of the cartilage varies: thus, *No. 37* showed complete repair in the 4th week: *No. 34* showed overgrowth by the same date: on the other hand, in some cases the repair material was still fibrous, without cartilage formation, as late as 12 weeks after operation.

Commonly in the rat the defect is filled with fibrous tissue by the end of the first week: after two weeks there is tissue transitional between fibrous tissue and cartilage, and after three weeks there are islets of new cartilage in the fibrous tissue. In some, the new cartilage was separated by fibrous tissue from the original cartilage, e.g., *No. 37*; in others it was continuous.

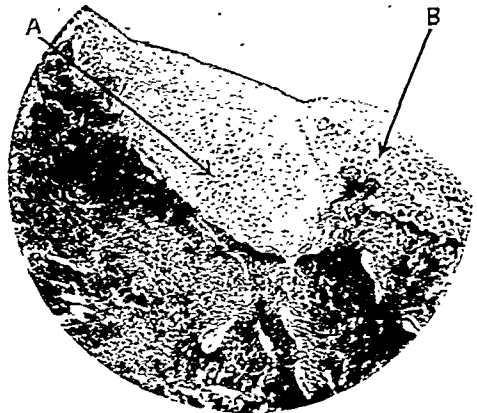


FIG. 36.—(*Experiment 37*). 'Examination 4 weeks after operation. A, Newly-formed cartilage; B, Articular cartilage (original).

In the rabbit (*No.* 34) three zones, fibrous, transitional, and cartilaginous, were definite.

In some specimens it appears that the reparative tissue has come from the underlying cancellous tissue, in others transitional cartilage-like tissue seems to arise in connection with the edges of synovial membrane, if the injury to the articular cartilage has approached them. Redfern and Timbrell Fisher have shown that repair near the margins is good, but that nearer the centre it is poor, unless the underlying cancellous tissue has been exposed.

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## A NOTE ON EXTERNAL DUODENAL FISTULA: WITH A RECORD OF SOME UNPUBLISHED CASES.

BY SIR HUGH M. RIGBY, K.C.V.O., LONDON.

AN external duodenal fistula is a much-dreaded sequel to disease of, or injury to, this portion of the alimentary tract. It is fortunately of somewhat infrequent occurrence. A recent paper on this subject (Cameron<sup>1</sup>), with a review of the literature, refers to 30 cases, but there are doubtless many others unpublished. The writer of this article has had personal experience of 4 cases which have been in his surgical ward at the London Hospital during the last twenty years, and, from the hospital records during that time, a further 3 cases have been found, which have been placed at his disposal by the kindness of his surgical colleagues. One of the writer's cases (*Case 1*) has only recently left the hospital, and this short paper is based largely on the experience gained from this patient.

**Etiology.**—As one might expect, the majority of external duodenal fistulæ result from operative procedures, either upon the duodenum itself or on neighbouring viscera, especially the gall-bladder and kidney. Traumatic rupture of the duodenum (other than by a shot wound) is rare, and 'war' injuries have not been considered in this paper.

An analysis of 30 cases reported in Cameron's paper (*loc. cit.*) shows the etiology of the condition as follows:—

### DUODENAL FISTULA RESULTING FROM:—

Operation on the duodenum for—	Cases		Cases
a. Perforation of ulcer ..	6	Operation on the gall-bladder ..	6
b. Traumatic rupture ..	5	Operation on the kidney..	7
c. Gall-stone in common bile-duct .. ..	1	Operation on the stomach ..	2
d. Carcinoma of the pancreas	1	Abscess in the loin .. ..	1
		Cause uncertain .. ..	1

The etiology of 7 cases occurring in the London Hospital surgical wards during the last twenty years is as follows:—

### DUODENAL FISTULA RESULTING FROM:—

Operation on the duodenum for—	Cases		Cases
a. Perforated ulcer ..	1	Operation on the stomach ..	2
b. Acute diverticulitis ..	1	Operation on the kidney ..	1
c. Traumatic rupture ..	1	Operation for appendix abscess ..	1

It appears from this short series that the majority of fistulæ in the duodenum are a direct result of operation for diseases of the duodenum itself (8 cases), of the right kidney (8 cases), or of the gall-bladder and bile-ducts, of which 7 examples are recorded; direct injury to the duodenum, treated by operation, is responsible for 6 cases, whilst operation on the stomach (4 cases), on the duodenum (cholecyst-duodenostomy) for carcinoma of the pancreas (1 case), appendix (1), abscess in the loin (1), and unknown cause (1), make up the remainder.



An external duodenal fistula occurring spontaneously, as a result of perforation of an ulcer and abscess formation, is very rare. One case has been recorded (Moynihan<sup>2</sup>).

It is significant that in the majority of these operations, as pointed out by Cameron, *gauze packing* was frequently used in addition to tube drainage.

**Diagnosis.**—The diagnosis of duodenal fistula depends upon the discharge from the wound of the characteristic duodenal fluid. This is usually bile-stained, but to a variable degree. It is viscid, alkaline in reaction, and may be discharged in enormous quantities. The amount discharged, however, varies considerably. It is difficult to measure the amount unless some form of permanent drainage apparatus is employed. In Cameron's case, quoted above, 700 c.c. were recorded daily, whilst in another patient (Erdmann<sup>3</sup>), no less than 4000 c.c. were collected in one day; subsequently, 50 to 60 oz. were discharged daily for eight days, after a jejunostomy had been made. It is easy to realize what a severe drain this must be on a patient enfeebled by a recent operation. On the other hand, the discharge in some recorded cases has been almost insignificant.

Next in importance to the actual amount is the irritating character of the discharge, and this again varies greatly. In some cases irritation of the surrounding tissues is hardly noticeable, whilst in others it is intense. Extensive burning of the skin, which causes agonizing pain, occurs, so that the constant dressings become almost unbearable.

**Symptoms.**—The symptoms caused by a duodenal fistula depend entirely on the amount and character of the discharge. In the ultra-acute cases, the rapidity with which a patient goes down-hill is most striking, and immediate operative treatment is urgently called for. Even the less acute cases, on account of the loss of sleep owing to pain, and progressive weakness from the constant dehydration, demand active surgical treatment if life is to be saved. In marked contrast are those where the discharge is scanty, does not irritate the tissues, and the symptoms are merely due to the discomfort of an occasional dressing.

**Prognosis.**—The accepted teaching that a duodenal fistula is an exceptionally grave lesion is mainly correct; but it is surprising to note how many have healed up, either with simple local treatment or as the result of some form of operation. Thus, in the 30 cases recorded in Cameron's paper, there were 18 recoveries. In 7 treated at the London Hospital between 1902 and 1923, recovery took place in all, and in 5 of these, healing of the fistula occurred without operation.

Prognosis as to the probable *duration* of the discharge depends on the amount and character of the fluid. Records show that, in the acute cases, death may occur in two or three days; in the less severe, discharge of fluid may cease after several weeks. In one remarkable case at the London Hospital (*Case 5*), under the care of my colleague, Mr. Russell Howard, an intermittent duodenal discharge had persisted for eleven years!

**Treatment.**—The treatment of a duodenal fistula depends upon the amount and character of the discharge and its effect upon the general condition of the patient. Operative treatment should not be considered at first unless urgent symptoms demand it. Local and general treatment alone may suffice.

**LOCAL TREATMENT.**—This consists in protecting the skin and, if possible, in some way preventing the discharge from coming into contact with the surrounding tissues. An ointment of oxide of zinc and castor oil, spread on lint, is useful; liquid paraffin has been successfully used in some cases. It is better not to employ either gauze or tube drainage. As the discharge is alkaline, acid solutions have been tried, but with little success and great discomfort to the patient.

*Suction of the fluid* has been employed with good results (Erdmann, Cameron). Cameron employed an electrical suction apparatus, but the constant noise of such an instrument prevents its employment in a general hospital ward. Erdmann drew off the discharge into a sterile bottle connected with a suction apparatus, and fed his patient through a jejunostomy opening with the duodenal secretions collected by this means! An ingenious frame, which enabled this to be done, is figured in an account of this case (*loc. cit.*).

A constant dilution of the discharge was successfully carried out in one case (Cheever), sterile water being used.

Cameron refers to two successful cases treated by Einhorn by means of his duodenal tube, but there are obvious limitations to this method.

**GENERAL TREATMENT.**—This consists in withholding fluid by the mouth as far as it is possible. Injections of saline and glucose should be administered by the rectum, and atropine may also be given as a means of lessening the amount of pancreatic secretion.

**OPERATIVE MEASURES.**—In the severe cases, some form of operation is imperative, in order to enable the patient to receive fluid, and so make up for the severe dehydration resulting from the continual discharge. The choice of operation rests between: (1) Gastro-enterostomy combined with occlusion of the pylorus (Berg<sup>4</sup>); (2) Jejunostomy; (3) Direct suture of the opening in the duodenum combined with either (1) or (2); (4) Direct suture alone.

1. *Gastro-enterostomy with Occlusion of the Pylorus.*—As treatment of a duodenal fistula, this was first suggested and performed by Berg. In 6 published cases, 4 recovered after this treatment: an immediate cessation of discharge followed in 3 cases. In the writer's patient (*Case 1*), the discharge decreased gradually for five days, and then a rapid improvement took place.

This treatment aims at cutting off the discharge of all stomach contents into the duodenum, thus removing the stimuli which encourage the flow of bile and pancreatic secretions. It has the great advantage that, within a few hours after operation, the patient can be given plenty of fluid naturally, and, after twenty-four hours, nourishment such as milk, eggs, Benger's food, etc. The chief disadvantage is that, in the already exhausted condition of the patient, such an operation may not be tolerated. Two cases reported by Berg proved fatal, although the discharge was efficiently checked. Another disadvantage is the obvious undesirability of short-circuiting a healthy stomach, a proceeding which may give rise to unpleasant sequelæ.

If Berg's method of treatment depends mainly on occlusion of the pylorus for its undoubted value in checking the duodenal discharge, it is difficult to explain how a duodenal fistula with much discharge can occur after a partial gastrectomy with closure of the first part of the duodenum. In Cameron's case (treated by suction) profuse duodenal discharge occurred after an anterior

Polya operation for cancer, and the careful record of this case seems to indicate that the discharge did come from the duodenum. A duodenal fistula (after partial gastrectomy) must be a very rare occurrence: notes of two cases only (Walton) were found in the London Hospital records up to date; they are included in the list at the end of this paper. The alternative hypothesis, that the fistula arose at the site of the anastomosis, is difficult to disprove, but is highly improbable.

2. *Jejunostomy*.—This operation, as an alternative method of introducing fluid, has much in its favour. It can be performed rapidly under local anaesthesia, and by improved methods in technique the fear of a permanent jejunal fistula should be negligible.

The choice of operative treatment usually rests between one or other of these methods.

3. *Direct Suture of the Opening Combined with Gastro-enterostomy and Closure of the Pylorus*.—One successful case (Souttar<sup>5</sup>) was operated on by this method at the West London Hospital in 1913. The patient, a girl, age 14, was admitted with a subhepatic abscess which was opened and drained; a duodenal fistula followed the operation. Nine days later a second operation was performed; an opening was found in the second portion of the duodenum; this was closed by sutures. The pylorus was infolded by Lembert sutures, and a posterior gastro-enterostomy made. The operation was completely successful. The duodenal ulcer was probably the result of a severe burn sustained by the patient eighteen months previously.

4. *Treatment by Direct Suture alone* is tempting, but the results have not been encouraging. Mayo achieved a brilliant success in one case, but the operation was done immediately after the discharge was noticed, and probably the deleterious effect of the tryptic fluid on the tissues was not established. In all the other reported cases the sutures subsequently gave way, and this cannot be wondered at when one has observed the intense irritation to which the tissues are subjected.

### ANALYSIS OF RESULTS.

Table I.—SIMPLE LOCAL TREATMENT: 13 CASES.

CASE		DURATION OF DISCHARGE	RESULT
1	Mayo ..	2 weeks .. ..	Died
2	Mayo ..	5 days .. ..	Died
3	Mayo ..	2 weeks .. ..	Died
4	Gardner ..	1 month .. ..	Recovered
5	Davis ..	12 days .. ..	Recovered
6	Palmer ..	8 days .. ..	Recovered
7	Hendon ..	5 weeks .. ..	Recovered
8	Stadler ..	1 month .. ..	Recovered
9	Author (Case 2)	3 months .. ..	Recovered
10	Author (Case 3)	1 month .. ..	Recovered
11	Author (Case 4)	11 days .. ..	Recovered
	Operation by Huddy <sup>a</sup>	.. ..	
12	Walton (Case 6)	9 days .. ..	Recovered
13	Walton (Case 7)	5 weeks .. ..	Recovered

Recovered, 10 cases; died, 3 cases.

*Table II.*—SUCTION TREATMENT: 3 CASES.

CASE		DURATION OF DISCHARGE	RESULT
1	Palmer Irrigation	10 days .. ..	Recovered
2	Cameron ..	11 days .. ..	Recovered
3	Cheever Irrigation and Syrphonage	Soon stopped ..	Recovered

Recovered, 3 cases.

*Table IV.*—BERG'S OPERATION: 6 CASES.

CASE		DURATION OF DISCHARGE	RESULT
1	Berg ..	Ceased at once .. ..	Died: exhaustion
2	Berg ..	Ceased at once .. ..	Died: shock
3	Cameron ..	Ceased almost immediately	Recovered
4	Knaggs ..	Marked improvement ..	Recovered
5	Thénevard ..	Not stated .. ..	Recovered
6	Author (Case 1)	Immediate improvement, discharge ceased after 5 days	Recovered

Recovered, 4 cases; died, 2 cases.

*Table V.*—JEJUNOSTOMY: 5 CASES.

CASE		DURATION OF DISCHARGE	RESULT
1	Esau ..	Not noted .. ..	Died in 6 days from exhaustion
2	Winewarter ..	Not noted .. ..	Died 2 days after
3	Pannett ..	Short time .. ..	Recovered
4	McGuire ..	Immediate improvement, and closure in 3 weeks ..	Recovered
5	Erdmann .. + Suction	10 days .. ..	Recovered

Recovered, 3 cases; died, 2 cases.

*Table VI.*—DIRECT SUTURE (ALONE OR IN COMBINATION): 4 CASES.

CASE		DURATION OF DISCHARGE	RESULT
1	Mayo ..	Stopped at once .. ..	Recovered
2	Souttar + Berg's Opn.	Stopped at once .. ..	Recovered
3	Koerte ..	Sutures gave way 2 days later	Died
4	Fruwaengler + Berg's Opn.	Suture line leaked ..	Died

Recovered, 2 cases (1 simple suture); died, 2 cases.

## CASES FROM THE LONDON HOSPITAL RECORDS.

*Case 1 (AUTHOR).—Traumatic rupture of duodenum; duodenal fistula.*

E. W., male, age 18. In October, 1923, the patient was playing Rugby football, was tackled, and fell forward on to the boot-heel of another player who was lying on the ground; the heel struck the patient in the epigastric region, and at the same time another man fell on his (patient's) back. He was helped up, but became unconscious for a few minutes. His abdomen was rubbed and he was able to walk off the field with help. He was sick, bringing up a little blood-stained mucus. When examined, an hour later, the pulse was 88. There was a bruise present over the upper part of the right rectus: no rigidity of the abdominal wall: no dullness in the loins: liver dullness present. Patient complained of severe spasmodic pains, and vomited repeatedly, chiefly mucus. He found lying on the right side the most comfortable position. His condition two hours later (7 p.m.) was much the same: there was no marked local rigidity or tenderness; still sickness; still spasmodic pain;  $\frac{1}{8}$  gr. morphia given.

At 9 p.m. the pain was much better and vomiting had ceased. Well-marked bruise in the upper part of the right rectus, which now seemed somewhat rigid. Patient slept until 3 a.m., when the vomiting and pain recommenced.

Next day, at 10 a.m., the patient was found to have rigidity in the right side of the abdomen. Temperature  $101^{\circ}$ ; pulse 100.

**FIRST OPERATION.**—At 1 p.m., Mr. Robert Going, F.R.C.S., of Littlehampton, opened the abdomen by a vertical incision to the right of the middle line, from the 'ensiform' to just above the umbilical line. The right rectus was retracted, and the posterior sheath opened. Later, to obtain more room, the rectus was divided transversely at the lower part of the incision. When the abdomen was opened, no free fluid was noticed at first. Emphysema was present in the gastrocolic omentum. The gall-bladder was full and adherent: some old adhesions between the gall-bladder and stomach were ligatured and divided. The gall-bladder was apparently intact. The first part of the duodenum was then examined. After separating some adhesions, what looked like a tear was found in the posterior peritoneum, close to the outer side of the second part of the duodenum; this was enlarged, and then a *small perforation in the duodenal wall* was seen: this was sutured, and the peritoneum and omentum were then sutured over it. The stomach was normal, the jejunum distended, the transverse colon normal and empty. Some bile-stained fluid was found in the right iliac region; this was swabbed out. A drainage tube was passed down to the renal pouch through a 'stab' opening in the right lumbar region. The lesser sac of the peritoneum was then explored: no fluid was found in it.

The patient became much collapsed, and the operation was finished quickly. The abdominal wall was sutured in layers. Patient rallied after a saline infusion: he had some post-anæsthetic vomiting. At 10 p.m. the pulse could be counted and was more regular.

Next day, Oct. 29, patient was much better: some bile-stained fluid escaped from the drainage tube: there was no abdominal distention. Patient improved during the day: the pulse became quite regular and he retained rectal saline injections.

Oct. 30. Patient steadily improved: no vomiting. Nutrients were given four-hourly and were retained: a small quantity of water was given by the mouth.

Oct. 31. General condition improving: had some feeds of milk and albumen-water.

Nov. 4. As the drainage tube appeared to be blocked, a stitch was removed and the tube altered in position: finally, it was removed and found to be blocked by a slough. A quantity of bile-stained fluid then came away: there was some infection of the incision in the right rectus. The bowels acted after an enema. In the evening a large quantity of fluid came away and escaped through the dressings.

Nov. 5. There was continued discharge from the tube: a large quantity of dark-coloured, viscid fluid escaped: this irritated the skin of the right flank, which

was deeply injected and acutely painful. The patient's general condition had changed for the worse. His eyes were sunken and he appeared much exhausted.

Nov. 6. Patient was sent up in an ambulance to the London Hospital, and seen by the writer the same afternoon, 6 p.m. The patient was evidently extremely ill. His eyes were sunken, his hands cold, and he was much exhausted. The tongue was dry and thickly coated. He did not complain of pain except when the wound was dressed. Below the ribs, in the right lumbar region, was a sinus with a drainage tube in it. The skin was intensely excoriated round this, over an area extending back in the right loin nearly to the spine: a large quantity of gelatinous-looking and slightly bile-stained fluid escaped. The dressings were continually soaked.

Temperature on admission  $97^{\circ}$ : pulse 100, small, very low tension; respirations 30. Rectal salines with glucose were ordered. As the patient was much exhausted by the long journey, it was decided to postpone operation until the next morning.

SECOND OPERATION, Nov. 7, 1923 (by the author).—The old incision was re-opened. Many adhesions were found to the right side of the abdomen: these were not interfered with. The stomach and first part of the duodenum appeared normal.

A posterior, no-loop, gastrojejunostomy was rapidly made, and the pylorus was then occluded by a purse-string suture of silk. A feed of beaten-up egg and peptonized milk was given (into the jejunum) at the time of the operation.

Nov. 8. The patient's condition was much the same, but he had rallied well from the operation: there was a little post-anæsthetic vomiting. He was able to take some fluid by the mouth; saline and glucose were given per rectum at intervals.

Nov. 9. The fistula was still discharging considerably: the skin round the orifice was raw and acutely painful: the dressings were soaked and required to be changed three times during the day and four times at night. He was taking a good amount of fluid by the mouth; at one time there appeared to be a little milk in the fluid escaping from the fistula.

Nov. 10. Patient propped up in a sitting position. He was looking better: his eyes less sunken. There was still a considerable discharge from the fistula, but patient was taking more fluid by the mouth, and also beaten-up egg, jelly, custard, etc. The skin was still very sore right round to the spine, although kept covered with emollient dressings. The discharge was alkaline, probably mainly pancreatic fluid.

Nov. 11 (4th day). Discharge appreciably less.

Nov. 12. Dressed only twice during the night; much less discharge on each dressing.

Nov. 13. Discharge quite slight: a very little thin fluid. Skin much less sore and inflamed: only one dressing required through the night.

Nov. 15. The patient's general condition was vastly improved. The eyes were not sunken, and he was sleeping and taking his food well. There was a very little discharge from the fistula: only one dressing was required every twelve hours. The skin round the fistula was rapidly healing.

Nov. 22. Fistula practically dry. From this date, patient made an uninterrupted recovery. The transverse portion of the abdominal incision gaped, but healed firmly by granulations.

Dec. 7. The patient was discharged from the hospital. Wound healed; general condition quite satisfactory. Pulse 82, temperature normal. Bowels acting normally.

He is in sound health at the present date.

Case 2 (AUTHOR).—F. H., female, age 39. A nephrectomy was performed at the London Hospital in 1910, for right pyonephrosis. The wound was drained for a time: it healed up slowly, and the patient left hospital two months later; she went to a convalescent home. Two days afterwards she complained of dragging pain in the right side, and vomited. The wound was opened up at the home; this

was followed by a sudden discharge of gas and a copious flow of thick yellow fluid tinged with green. Patient was re-admitted to hospital. The skin was much ulcerated and painful, and there was a free discharge of duodenal fluid from the wound. At one time, portions of an egg which had been eaten were found on the dressing. The discharge gradually became watery: it continued for two months and then ceased spontaneously. Her general condition at one time gave rise to anxiety. Treatment consisted in frequent dressings, and emollients for protection of the skin.

*Case 3 (AUTHOR).*—A. D., male, age 15. A case of appendix abscess, operated upon at the London Hospital in 1907. A large abscess of ten days' duration, tracking upwards towards the right kidney, was opened and drained with two tubes and gauze. The lower end of the kidney was palpable at the time of operation. The appendix could not be removed. The tubes and gauze were removed three days after operation, when a copious discharge of thin, sour fluid, containing bile, took place. The fluid irritated the skin: this continued for five days, and necessitated frequent dressings. The patient's general condition remained good, the discharge gradually lessened, and had completely ceased three weeks after operation.

*Case 4 (AUTHOR).*—Female, age (?). This case of acute diverticulitis of the duodenum was reported in the *Lancet*, 1923.<sup>6</sup> Operated on by Mr. G. P. Huddy, Surgical Registrar at the London Hospital. An inflamed and partly gangrenous diverticulum was found in the second portion of the duodenum, and was excised. Three days after operation, a discharge of brownish, watery fluid occurred. This was never profuse; the patient's condition gradually improved, and the wound healed fourteen days after operation. There was never any appreciable irritation of the edges of the wound.

*Case 5 (MR. RUSSELL HOWARD).*—G. B., male, age 66. A patient at the London Hospital in 1913. He had been operated on for a subhepatic abscess eleven years previously. A duodenal fistula, containing bile, resulted, and this had continued ever since. His general health was never much impaired, but the skin was always somewhat inflamed and the discharge was, at times, copious: it varied considerably from time to time. The patient at times plugged the wound and checked the discharge. When admitted to hospital, the patient was in good condition; the skin round the fistula was inflamed; the amount of discharge was not excessive, as the dressings had only to be changed three or four times a day.

Operation by Mr. Russell Howard. The abdomen was opened and a fistula was found opening into the first part of the duodenum. The duodenum was separated from the abdominal wall, and the opening closed by sutures. The abdominal wound was then repaired. The operation was completely successful.

The interesting features of this case are the duration of the discharge, and the ease with which the operation was performed; there was a surprising absence of adhesions in the operation area.

*Case 6 (MR. A. J. WALTON).*—H. S., male, age 54. This patient was operated on in the London Hospital in 1921 for carcinoma of the stomach. A partial gastrectomy was performed. The patient made a good recovery and left the hospital three weeks after operation. Next day a discharge occurred from the wound and he was re-admitted. There was a free discharge of alkaline, bile-stained fluid. Local treatment was adopted, and the discharge, which had never been excessive, ceased spontaneously nine days later. There was some irritation of the surrounding skin. The patient's general condition was good, and he is, at present, in sound health.

*Case 7 (MR. A. J. WALTON).*—C. S., female, age (?). Operated on at the London Hospital for a lesser-curve carcinomatous ulcer of the stomach. Partial gastrectomy was performed. The growth was adherent to the mesocolon. Twenty-three days after operation, a fistula developed, which persisted for five weeks. The discharged

fluid was bile-stained, faintly acid in reaction, and contained pus and coliform bacilli. The fistula slowly healed up. The patient was discharged from hospital in fair condition, but has since failed to report at the 'follow up' department.

### CONCLUSIONS.

1. A duodenal fistula is a serious, but by no means fatal, condition.
2. In the less severe cases, simple local treatment may be tried.
3. In the acute cases, operative treatment is urgently called for, the choice lying between Berg's method and a jejunostomy.
4. Some form of suction apparatus is of much value from the nursing point of view, and adds greatly to the comfort of the patient.

I have drawn largely from Dr. Angus Cameron's excellent paper and careful record of the literature of this subject. My thanks are also due to Mr. Hamilton Bailey, F.R.C.S., my chief assistant at the London Hospital, for valuable help in the preparation of this paper.

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- <sup>3</sup> ERDMANN, *Ann. of Surg.*, 1921, lxxiii, 793.
- <sup>4</sup> BERG, *Ibid.*, 1907, xlv, 721.
- <sup>5</sup> SOUTTAR, *West London Med. Jour.*, 1913, xviii, 133.
- <sup>6</sup> HUDDY, *Lancet*, 1923, ii, 327.



## TRAUMATIC DISLOCATION OF THE HIP IN CHILDHOOD, AND RELATION OF TRAUMA TO PSEUDOCOXALGIA:

ANALYSIS OF 59 CASES PUBLISHED UP TO JANUARY, 1924.

By C. C. CHOYCE, LONDON.

*THIS condition is very rare, having only been previously recorded on fifty-three occasions, but attains interest because in several recent cases sequels have occurred many months after the primary accident. In two cases definite pseudocoxalgia has followed (Elmslie and Rehbein), although radiograms taken*

*at the time of the accident showed normal shape of the acetabulum and femur; in a third the sequel was rarefaction of the femoral neck and subluxation of the head (Higgins). Elmslie and Rehbein both suggest that the changes in the femoral epiphysis are due to loss of the vascular supply that should accompany the ligamentum teres, of necessity ruptured by the accident. The condition, therefore, becomes interesting from the points of view of prognosis and of a suggestion as to a factor in the production of pseudocoxalgia. It seems worth while, for these reasons, to record a recent*



FIG. 37.—Traumatic dislocation of hip. Radiogram taken before reduction.

and to make a short analysis of previously reported ones. It is my intention to follow up my patient systematically with a view to the discovery of sequelæ. The accompanying table contains every case in the literature that I have been able to find, fifty-three in all; it also includes my own recent case, and five others collected from the surgical case-books of University College Hospital.

My own case is that of a boy (Harold B.), age 6 years, who during play endeavoured to carry on his back another boy, age 12. He was unable to bear the weight, his legs straddled, and the two boys fell, the elder and

heavier being on the top. A week later, on May 25, 1923, he was seen by Dr. Lightfoot, who diagnosed dislocation of the hip and sent the patient to hospital. He showed all the classical signs of a dorsal dislocation of the left hip; radiography confirmed the diagnosis and showed no signs of any concomitant fracture (*Fig. 37*). Reduction, under light anæsthesia, was readily accomplished by the usual manœuvres: traction, slow adduction, followed by outward circumduction and by rapid extension of the limb. An X-ray picture taken the next day showed that the head of the femur was in the acetabulum, and that there were no evidences of any damage to the epiphysis of the femoral head or any other abnormality. Movements of the hip, in bed, were free and painless. When I saw the boy six weeks later, the hip still appeared normal. He walked and ran without a limp, passive movements were free and painless in all directions, and a radiogram showed no abnormality. I have recently seen him again, on Jan. 10, 1924. He runs and walks freely without limp or pain. A radiogram (*Fig. 38*) shows no definite abnormality, though the outlines of acetabulum and femoral head are not quite so sharp-cut as in some pictures.



FIG. 38.—Traumatic dislocation of hip. Radiogram eight months after reduction.

Analysis of the reported cases reveals the following points:—

1. **Rarity.**—Only 59 cases are recorded. Maffei states that of 1842 hip luxations observed at the Rizzoli Institute of Bologna since 1901, there were only 3 traumatic dislocations in childhood.

2. **Sex.**—Males. 42; females. 16; not stated, 1.

3. **Age.**—From 11 months to 16 years (an old-standing case). Average about  $7\frac{1}{2}$  years.

Ages				Cases	Ages				Cases
Between	0 and	3	..	2	Between	11 and 13	..	6	
..	3 and	5	..	6	..	13 and 15	..	8	
..	5 and	7	..	13	..	15 (an old-standing	..	1	
..	7 and	9	..	12	..	case)	..	1	
..	9 and	11	..	10	..	Not stated	..	1	

4. **Side.**—Right, 22; left, 27; not stated, 10.

5. **Variety of Dislocation.**—Iliac (dorsal). 40; obturator, 7; sciatic, 6; suprapubic, 3; not stated, 3.

## RECORDED CASES OF TRAUMATIC DISLOCATION OF THE HIP IN CHILDHOOD. Up to January, 1924.

No.	NAME OF SURGEON	JOURNAL	SEX	AGE, YEARS	SIDE	TYPE	DURATION BEFORE TREATED	METHOD OF REDUCTION	FINAL RESULTS AND NOTES
1	Bartels ..	<i>Arch. f. klin. Chir.</i> 1874, xvi	?	1½	L.	Iliac	1 day	Manipulation ..	?
2	Bartels ..	Ditto ..	F.	14	R.	Iliac	?	Spontaneous reduction whilst being carried	?
3	Volkmann ..	<i>Deut. Zeits. f. Chir.</i> 1893, xxxvii	M.	13	L.	Iliac	13 weeks	Manipulation failed; femur broken	Hip ankylosis followed
4	Klee ..	<i>Brun's Beiträge z. klin. Chir.</i> 1889, iv	F.	8	R.	Iliac	3 days	Manipulation ..	?
5	Klee ..	Ditto ..	M.	14	L.	Sciatic	2½ months	Manipulation failed	?
6	Helferich ..	<i>Deut. med. Woch.</i> 1898, No. 32	M.	1½	L.	Iliac	24 hours	Manipulation ..	?
7	Helferich ..	Ditto ..	F.	4	L.	Iliac	14 days	Manipulation failed. Reduced by open operation	'Ideal'
8	Volkmann ..	<i>Deut. Zeits. f. Chir.</i> 1893, xxxvii	M.	9	R.	Iliac	7 weeks	Manipulation failed. Open operation; reduction	'Ideal' in 9 months
9	Drehmann ..	<i>Brun's Beiträge z. klin. Chir.</i> 1896, xvii	M.	7	R.	Iliac	3½ weeks	Manipulation after extension with weights	Good in a month
10	Drehmann ..	Ditto ..	M.	8	L.	Iliac	4 weeks	Manipulation only apparently succeeded. Dislocation persistent after removal of plaster. Open operation. Epiphysis found separated. Relaxed and reduction made	Walking with stick at end of 4 weeks
11	Endlich ..	<i>Arch. f. klin. Chir.</i> 1898, lvi	M.	5	L.	Iliac	Old date	Open operation ..	Good 1 year, and still good 4 years after
12	Endlich ..	Ditto ..	M.	9	L.	Obturator	9 weeks	Open operation: reduction, but not stable. 2nd operation 2 months. Sequestrum formation in femoral head and necrosis of cartilage	3 years later: 'satisfactory'
13	Schoemann	Quoted by Doelle in <i>Arch. f. klin. Chir.</i> 1921, cxviii, 725	F.	7	L.	Obturator	?	Resection of hip ..	?
14	Cripps, Law-	Ditto ..	F.	4½	R.	Obturator	1½ months	Reduced by manipulation	?

No.	Author	Ref.	Age	L.	Line with infratrochanteric fracture	Time	Operative reduction. Suppuration	Went in 4 weeks. Sequelae, fibrous ankylosis
17	Hölliger	..	5½	L.	Line	4 months	Operative reduction. Suppuration	Went in 4 weeks. Sequelae, fibrous ankylosis
18	Gerstner	..	8	?	Line	7 weeks	Operative reduction. Spontaneous redissolution 1½ months later. Second operation: remained reduced	?
19	Spencer	..	7	R.	Line	—	Reduced but recurred. Operation 5 months later	Good. Could walk
20	Bell	..	13	?	Line	5 months	Operative reposition with subperiosteal separation of muscles from trochanter	Good
21	Jones, Sidney	..	11	?	Line	6 weeks	Manipulation failed. Operation: failure of reduction by open method. Resection of head	4 years later could run and walk
22	Tuchten	..	10	?	?	recent	Reduced by manipulation	{ Good } ( brother and sister )
23	Tuchten	..	8	?	?	recent	Ditto	
24	Hadke	..	14	L.	Line	10 weeks	Reduced by open operation	7 weeks later movements were good
25	Seiderer	..	10	L.	Obturator	?	Reduced by Kocher's method of manipulation	Went in 10 days
26	Peschies	..	6	?	Line	2 months	Open operation	?
27	Stressler	..	14	R.	Obturator	5 weeks	Manipulative attempts fractured upper third of femur. Fracture united. Then reduction by open method after 11 weeks	Legs equal in length & movements good
28	Bajardi	..	5	L.	Suprapubic	—	—	—
29	Dollinger	..	8	R.	Line	3 months	Manipulation failed. Open operation	3 years later, walking good and movements complete
30	Boehnke	..	5	L.	Line	3 months	Manipulation failed. Extension for 17 days. Manipulation again failed. Reduction by open operation	?
31	Jahrauer	..	10	L.	Line	?	?	?

## RECORDED CASES OF TRAUMATIC DISLOCATION OF THE HIP IN CHILDHOOD—continued.

No.	NAME OF SURGEON	JOURNAL	SEX	AGE, YEARS	SIDE	TYPE	DURATION BEFORE TREATED	METHOD OF REDUCTION	FINAL RESULTS AND NOTES
32	Weil ..	Ref. <i>Zentralb. f. Orthop.</i> 1910 ..	M.	11	L.	Suprapubic	?	Manipulation ..	Good
33	Weil ..	Ditto ..	M.	?	?	Iliac	?	Non-reduction of hip. Osteotomy to correct position	?
34	Rischbieth ..	<i>Lancet</i> , 1914, April 18	M.	10	?	?	?	Reduced by manipulation ..	Good. Walking in 28 days
35	Platt and von Mengershausen	<i>Lancet</i> , 1916, Jan. 8	M.	6	L.	Iliac	1 hour	Ditto ..	Walking in 1 month
36	Courtillet et Lombard	<i>Rev. Orthop.</i> 1911, v, 477	F.	3½	R.	Iliac	70 days	Ditto. Redislocation after 10 days. Reposition	Cure
37	Karenke ..	<i>Munch. med. Woch.</i> 1907	M.	13	L.	Sciatic	1½ hours	Reduced by manipulation ..	Good
38	Ritter (Doelle)	Ditto ..	M.	11	R.	Iliac	24 hours	Ditto ..	Ditto
39	Ritter (Doelle)	Ditto ..	M.	11	R.	Sciatic	2 hours	Ditto ..	Very good
40	Maffei ..	<i>Chir. d. Org. del Movimento</i> , 1922, vi, 619	M.	9½	R.	Suprapubic	2½ years	Partial removal of femoral head and osteotomy of the femur	Ultimately satisfactory function
41	Maffei ..	Ditto ..	M.	13	R.	Iliac	5 months	Reduction by open operation ..	Good function after 1½ months
42	Maffei ..	Ditto ..	M.	6	L.	Iliac	48 hours	Reduction by manipulation ..	Perfect function after 2 months
43	Mouchet et Seguinot	<i>Rev. d'Orthop.</i> 1910	M.	16	L.	Iliac	11 years	Operation refused	Good
44	Mouchet et Seguinot	Ditto ..	M.	9	R.	Iliac	Recent	Reduction by manipulation at the second attempt	Good
45	Roederer ..	Quoted by Maffei	M.	10	L.	Iliac	6 years	Operation refused	—
46	Roello ..	<i>Chir. d. Org. del Movimento</i> , 1922, vi, 119	F.	5	R.	Sciatic	Several hours	Reduced by manipulation ..	Complete return of function
47	Roello ..	Ditto ..	M.	6	R.	Sciatic	A few hours	Ditto (Kocher's method)	Perfect function in 12 days

made to find the following:—

	49	Steinke	..	Quoted by Maffie	M.	10	R.	Iliac	Recent	Ditto ..	Good result
50	Rehbein	..	..	<i>Deut. Zeits. f. Chir.</i> 1922, clxxiv, 416	M.	8	R.	Iliac	A few hours	Easily reduced by manipulation. Radiograph showed normal-shaped head. Left hospital in 2½ weeks without any disability	1 year later was readmitted with the clinical and radiographic picture of Perthes' disease. (Rehbein suggests that it is due to injury of blood-vessels in ligamentum teres) ?
51	Murphy, D. P.	..	..	<i>Jour. Amer. Med. Assoc.</i> 1923, lxxx, 549	M.	8	L.	Iliac	A few hours	Easily reduced by manipulation under ether	In a few months developed limp.
52	Higgins, T. T.	..	..	<i>Proc. Roy. Soc. Med. (Surg. Sect.)</i> , 1920-21, xlv, 62	M.	8	R.	Obturator	?	Aug., 1919: Reduced by manipulation. Plaster case. Femoral head and neck normal as seen by X rays	Nov., 1920: Radiograph shows rarefaction of femoral neck; epiphysis well formed. Some subluxation of head of femur upwards and backwards followed 1 year later by pseudo-coxalgia
53	Elmslie	..	..	<i>Jour. Orthop. Surg.</i> 1916, 1, 109	M.	4	L.	Iliac	8 days	Feb., 1914: Reduced by manipulation. X ray then showed normal-shaped head, now in acetabulum again	Running and walking freely six weeks later; radiogram then showed apparently normal hip. 8 months later (Jan., 1924): No abnormality; runs and walks freely
54	Choyce, C. C.	..	..	Personal case	M.	6	L.	Iliac	7 days	May 25, 1923: Reduced easily by Bigelow's manipulation under anaesthesia	Running and walking freely six weeks later; radiogram then showed apparently normal hip. 8 months later (Jan., 1924): No abnormality; runs and walks freely

## RECORDED CASES OF TRAUMATIC DISLOCATION OF THE HIP IN CHILDHOOD—continued.

No.	NAME OF SURGEON	JOURNAL	SEX	AGE. YEARS	SIDE	TYPE	DURATION BEFORE TREATED	HISTORY, AND METHOD OF REDUCTION	FINAL RESULTS AND NOTES
55	Collected by C. C. Choyce	Surgical case notes, University College Hospital, London	M.	6	R.	Iliac	1 day	July, 1897. Climbing on a board, which fell with him. Reduced by manipulation	Left hospital in one week; walking well. No subsequent history — not traced
56	Ditto ..	Ditto ..	M.	8	L.	Iliac	1 day	Nov., 1898. Fell when carrying another boy on his back. Re- duced by manipulation under chloroform	Went out of hos- pital in 4 days in Thomas's hip splint. Subse- quent history not noted—not traced
57	Ditto ..	Ditto ..	F.	4	R.	Iliac	2 days	1889. Fell from sister's arms. Easily reduced by manipula- tion under ether	Double Thomas's hip splint. Sub- sequent history not noted — not traced
58	Ditto ..	Ditto ..	M.	6	?	Iliac	1 day	1888. Pushed over from behind by another boy. Reduced by manipulation under chloro- form	Thomas's hip splint. Left hospital on 4th day. Subse- quent history unknown
59	Ditto ..	Ditto ..	M.	11½	L.	Iliac	1 day	1887. Tripped and fell with legs widely separated	Left hospital on 16th day—able to walk. Sub- sequent history unknown

**6. Method of Reduction.**—Manipulation, usually under anæsthesia, was successful in all cases in which it was tried within fourteen days from the date of the dislocation. In one of Helferich's cases (an iliac dislocation) it failed on the fourteenth day, and resort was had to open operation; the same was true of Hirsch's case. On the other hand, manipulation was successful as late as seventy days after dislocation in Courtillet and Lombard's case of iliac dislocation in a girl of  $3\frac{1}{2}$ ; redislocation occurred ten days later, but reposition resulted in cure. The cases requiring operation ranged in duration from fourteen days to two and a half years; two later cases (six years and eleven years' duration) refused operation. Various operative measures were adopted: the most satisfactory route of access appears to have been by subperiosteal detachment of muscles from the great trochanter, or by detachment and subsequent fixation of the trochanter. In some cases operative clearance of the acetabulum and reposition of the femoral head was successful; in others resection of the femoral head was adopted.

**7. Results.**—Late results are seldom mentioned, especially in the earlier cases, the recorder being content to state the results as good, ideal, etc. In recently reported cases, however, several late sequels have been reported; it is reasonable, therefore, to believe that had the earlier cases been followed up the results would have been found to be less ideal than was supposed. Thus, in Elmslie's case limping began eleven months later and the condition progressed to one of pseudocoxalgia. Again, in Rehbein's case there were well-marked signs of pseudocoxalgia twelve months later. Both Elmslie and Rehbein suggest that the subsequent changes are due to tearing of the ligamentum teres and interference with the vessels running in it, which take a more important share in the nourishment of the femoral head in childhood than later, when the epiphyseal plate of cartilage between head and neck is less complete. In Higgins' case, too, late changes appeared in the head and neck; fifteen months after the accident there was limping, and a radiogram showed rarefaction of the femoral neck, and, although the epiphysis remained of good shape, there was some subluxation of the head of the femur upwards and backwards. It would appear advisable, therefore, to give a guarded prognosis as to ultimate changes; limping is apt to recur after a period of about a year, and pseudocoxalgia and similar changes may then be found.

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(The above contain references to 49 cases collected from the literature. I add the following 5 cases, making a total of 54 recorded up to January, 1924.)

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## THE ETIOLOGY OF THE FEMORAL HERNIAL SAC.\*

By J. PHILIP BUCKLEY, MANCHESTER.

I AM about to express opinions which I have been developing since 1911, and regarding which I have in succeeding years become more and more confident. My conclusions are based largely on clinical and operative observations. I purposely refrain from commencing the consideration of this subject by trying to show how it is that femoral hernia is more common in women than in men. It confessedly occurs quite commonly in males but more commonly in females. If we approach the subject by discussing why this is the case, there is a danger that our clear vision may be fogged when we come to consider, as I intend to do, why in a given case of femoral hernia, whether in a male or in a female, that hernia has developed.

In discussing the subject I must first briefly recall a few anatomical details of a simple kind; then I shall enumerate the various types of femoral hernia met with clinically; thirdly, I shall mention existing theories and attempt to disprove them; and finally my own views will be given. As an appendix, a few words will be added about the relative frequency in the sexes.

**Anatomy.**—Femoral hernia develops in the potential space between the femoral vein and the free edge of Gimbernat's ligament. On the inner side of this so-called crural ring is the resistant, sharp edge of Gimbernat's ligament; on the outer side is the collapsible femoral vein, whose collapsibility is somewhat masked in the normal unherniated subject by some fibrous tissue loosely attached on the one hand to Poupart's ligament, and on the other hand to the horizontal ramus of the pubis; anteriorly the ring is bounded by the resistant Poupart's ligament, and deeply by the horizontal ramus of the pubis covered by the pectineus muscle and fascia. On the abdominal side of the ring is properitoneal fat in direct continuity with what is known as the cribriform fascia, which is simply a tough fibro-fatty plug occupying the crural ring. The properitoneal fat, situated at the angle between the anterior abdominal wall and the brim of the true pelvis internally, and the wing of the ilium externally, is loose, easily stretched, and in some considerable quantity. Deep again to this fat is the peritoneum, itself loose and stretchable and having a definite adhesiveness to the properitoneal fat, so that when the one is pulled upon, the other is dragged with it. Superficially to the crural ring is the loose connective tissue of the thigh.

**The Various Types of so-called Femoral Hernia met with Clinically.**—I say 'so-called', because, accepting the definition of an abdominal hernia as a protrusion of an abdominal viscus through the parietes, we find that not all loosely called femoral herniæ do actually hold contents.

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\* Paper read before the Manchester Surgical Society, April, 1923.

### 1. *Uncomplicated Herniæ.*—

*a.* A protrusion of properitoneal fat through the crural ring, expanding into the connective tissue of the thigh, covered by and definitely demarcated from the thigh fat by a smooth, thin, delicate fascia. It forms a soft, defined, subcutaneous mass in the upper part of the thigh, easily felt on palpation but not very obvious on mere inspection, and containing no peritoneal sac.

*b.* Commoner than the first type, but resembling it clinically in every way, and only differing from it in that it is usually larger, and that in the midst of the fatty mass is a definite but empty peritoneal sac in direct continuity with the general peritoneal cavity by means of a very narrow neck, through which it is difficult to squeeze even the first joint of the little finger, but which is easily and permanently stretched by inserting the closed blades of a pair of Spencer Wells' forceps and opening them. This feature explains why mention has been made of the presence of some fibrous tissue on the outer side of the neck of the sac, which masks the collapsibility of the femoral vein.

*c.* A similar type of peritoneal sac covered by a thick layer of properitoneal fat, but containing omentum. This, in my experience, is the commonest type. In virtue of its contents it is larger and more conspicuous than the second type, and its neck is wider, being stretched by the omentum passing through it.

*d.* The sac is larger, and its properitoneal covering is thinned by the expansion of the sac secondary to the increase in the amount of the contents. It usually contains omentum only, but in an old hernia in which the neck has been very widely stretched bowel may, but in my experience uncommonly, occupy the sac without being strangled.

Here I feel I must call attention to a statement in a well-known textbook on surgery,<sup>1</sup> because it is so contrary to my own experience. It says: "Femoral herniæ are less liable to contain omentum than the inguinal variety; a portion of the ileum is most often present". It may be acknowledged that in cases which are operated on for strangulation the strangulated viscus is almost always the ileum: but surely the contents of an uncomplicated femoral hernia are in the large majority of cases omentum.

### 2. *Complicated Herniæ.*—

*a.* Strangulation of properitoneal fat in the variety where there is a fatty sac without contents. I have seen one case of this type where suddenly the properitoneal fat with its contained sac was forced down, with the formation of a tense swelling, which was tender to the touch, but was accompanied by no vomiting and practically no shock. On exposure, the fatty sac had a faint mottled purple colour due to the passive hyperæmia. This case was admitted to the Manchester Royal Infirmary as an 'urgency'.

*b* The type where omental contents have become strangled.

*c.* The type where a knuckle of bowel has been forced through the narrow neck of the sac and become strangulated. Sometimes only a portion of the lumen of the bowel is involved, producing the partial enterocele of Richter. Usually in neither of these forms does the bowel occupy the whole sac, and this fact, of course, strongly supports the theory of a pre-formed sac.

## THEORIES OF SAC FORMATION.

Having mentioned the various types of femoral hernia, which later will be seen to be of importance in the development of my theory, I shall now proceed to state and briefly criticize the existing theories. These, as far as I am aware, are two in number: (1) That which Murray<sup>2</sup> refers to as the 'orthodox teaching'; and (2) That of Hamilton Russell,<sup>3</sup> which he calls the 'saccular theory'. The latter theory was strongly supported by Murray.

**1. The Orthodox Theory.**—The so-called orthodox theory holds that the sac of a femoral hernia develops contemporaneously with the extrusion of the viscus. Thus, to quote from Gray's *Anatomy*:<sup>4</sup> "When a portion of intestine is forced through the femoral ring it carries with it a pouch of peritoneum, which forms the hernial sac".

Now I maintain, and I think the supporters of Russell's 'saccular theory' do so too, that this theory is quite put out of court by the fact that we frequently meet with those cases mentioned above of an empty sac, richly covered with properitoneal fat and having a very narrow neck. When we meet with such cases at operation it is to my mind obvious that they have never held any contents, because, firstly, if the contents had been passive omentum, that omentum would have been held so tightly at the neck that it would never have been possible for it to have returned into the abdomen and it would soon have acquired adhesions at the neck, a condition which is almost always found to exist when omentum is present in the sac; secondly, if the contents had been bowel, that bowel must have been strangulated by the narrow neck, which condition would have manifested itself by symptoms of strangulation and obstruction. Again, when we come across cases of strangulated gut in a femoral sac, that gut is almost always smaller than the sac itself, and this alone strongly suggests that the sac has been a pre-existing one

**2. The Saccular Theory.**—Hamilton Russell defines his theory thus:<sup>5</sup> "The theory rejects the view that hernia can ever be 'acquired' in the pathological sense, and maintains that the presence of a developmental peritoneal diverticulum or sac is a necessary antecedent condition in every case of ordinary abdominal hernia".

Murray explains this theory, as applied to femoral hernia, fully and with care in his book *Hernia, its Cause and Treatment*. In criticizing the theory, I propose to follow his line of thought as expressed in this book. He says:<sup>6</sup> "It is then surely reasonable to believe that a crural gubernacular attachment, developed in excess of the normal, may, without producing an abnormal descent of the testicle, drag upon the peritoneum sufficiently to make a dimple in the crural region, which, with the growth of the individual, will develop into a potential hernia sac". As I understand it, this means that the crural attachment of the gubernaculum, excessively developed, arches round the external pillar of the external ring of the inguinal canal, reaches the groin, and, burrowing up between the femoral vein and Gimbernat's ligament, attaches itself to the peritoneum, and by muscular or cicatricial contraction drags down that peritoneum to form the sac of a potential femoral hernia.

Murray supports Russell's theory as follows. He mentions a case, described

by Macready in his *Treatise on Ruptures*, where three femoral sacs were present.<sup>7</sup> "one in the usual position of a femoral hernia, a second peritoneal sac had traversed Gimbernat's ligament, and a third protruded over and to the outer side of the femoral artery". Murray says,<sup>8</sup> "the fact that three diverticula were found in close proximity is in favour of the developmental view", and adds,<sup>9</sup> "that view receives support from their shape, for it is distinctly stated that the abdominal entrance of both these pouches was narrower than the fundus. Had these diverticula been produced by the bowel pushing the peritoneum in front of it, then the mouth of each sac would have been wide". The first of these reasons seems to give no valuable support to the theory. The second statement is true, but does not seem exclusively to support the congenital theory. It seems only to exclude the 'orthodox' theory.

Murray notes<sup>10</sup> that Macready, referring to persons seen at the City of London Truss Society during 1888, 1889, and 1890, records 22 cases of femoral hernia in males under 15 years of age, and 42 in females; but he does not mention that these were taken from a total of 461 males on the one hand, and of 1197 females on the other; nor does he tell us that among the males not one of the cases occurred in the period of 1 to 5 years, and among the females none occurred under 1 year and only five under 5 years; whereas in a condition acknowledged by all to be of congenital origin, viz., inguinal hernia, in males more than a sixth and in females nearly a seventeenth occurred before the age of one year, according to statistics taken from the London Truss Society's Clinic. Surely, if the sac of a femoral hernia were a congenital one, we should expect that those children who became actually ruptured during the first fifteen years of life would be much commoner than one twenty-sixth of all cases. For the same period—viz., the first fifteen years of life—in cases of inguinal hernia the proportion is midway between one-third and one-fourth. Apparently in this connection the proportion would be higher if direct and therefore acquired inguinal herniæ had not been included in the statistics of the Clinic; I presume that they were so included in the absence of any statement by Macready to the contrary.

Further, Murray says<sup>11</sup> that in 200 consecutive post-mortem examinations, femoral diverticula were found in 47 bodies.

According to the theory which I shall later expound, this is not a very surprising thing quite apart from a congenital explanation. Also it would seem extraordinary, assuming Russell's theory to be correct, that in 23 per cent of cases what must be described as a developmental abnormality should have occurred. Keith, I believe, points out that no one has seen a diverticulum within the femoral canal at birth. Murray does indeed mention that in Ashby and Wright's *Diseases of Children* it is stated that Sabourin recorded a case of femoral hernia in a premature infant.

Finally Murray says<sup>12</sup> that "if the sac of a femoral hernia is formed originally in this way" (viz., "by some force pulling, rather than pushing, the peritoneum outwards"), "then some atrophied gubernacular fibres should be found at the fundus of the sac". He writes, "a few weeks after I had written the above remarks I secured in the post-mortem room the sac of a femoral hernia from the body of a man 61 years of age". This he sent to

the Clinical Research Association in London for microscopical examination. He received the following report: "Sections made longitudinally of the fundus of this hernial sac certainly show small bundles of striated muscle". Murray does, however, confess in a footnote that "recently I sent two femoral hernial sacs to the Clinical Research Association for examination, but the presence of muscle fibre at the fundus of the sac could not be demonstrated". Again he says, "I have not yet had the opportunity of searching for muscular fibres at the fundus of a femoral hernia sac in a woman, but I feel confident of finding them there".

Embryologists in general definitely and dogmatically assert that the muscle fibres of the gubernaculum are non-striated. But quite apart from this question as to whether these fibres are striated or not, who would expect that in a sac alleged to be 61 years old fibres of muscle would still remain in a condition to be defined—a very delicate muscle at its best, and one which had not been called upon to contract for 61 years! Murray clears up the question of striation or non-striation of the gubernacular fibres to his own satisfaction by demonstrating striated muscle fibres from "behind and below the epididymis of an adult".<sup>12</sup> He briefly says, "it represents normal gubernacular fibres in the mesorchium". One wonders, however, if these are not more likely to be fibres of the cremaster muscle.

I have spent some space in questioning the correctness of Russell's theory as applied to the femoral sac, more especially because in perusing recently a paper by Panton,<sup>13</sup> "Factors bearing upon the Etiology of Femoral Hernia", to which I shall have occasion to refer later, I note that he accepts Russell's theory of the formation of the femoral sac, and accepts it, I think, too readily. One point especially appears to throw doubt on the congenital saccular theory which has as its basis the excessive growth of the gubernaculum; that point is the fact that although femoral hernia is more common in the female, yet in the female the gubernaculum is a much less active structure, if physiological results are anything to go by.

**3. The Author's Theory.**—My theory will not take long to enunciate. It is very simple and easy to understand. It may be called the 'acquired saccular theory', in contradistinction to the 'saccular theory' of Hamilton Russell, in which the sac is regarded as congenital or embryonic.

Man has an acknowledged weakness in the abdominal parietes at the crural ring. On the abdominal side of the ring we have an accumulation of loose properitoneal fat, which on its deep aspect has a certain adhesiveness to the peritoneum, which in its turn is loose and easily stretched. On its superficial aspect this fat is in direct continuity with the fat which plugs the space known as the crural ring. I have formed the opinion that under the influence of intra-abdominal pressure the properitoneal fat is herniated under Poupart's ligament between the femoral vein and Gimbernat's ligament into the thigh, carrying with it a small peritoneal diverticulum. Having once passed the narrow neck, it is allowed to expand into the connective tissue of the thigh, which is less resistant than the tissues around the neck of the sac. This expansion after passing the neck prevents its easy return through the crural ring. Occasionally the hernia of the properitoneal fat fails to bring down a peritoneal diverticulum, and we then get the type which I have

mentioned as the protrusion of properitoneal fat not containing a sac. It would appear to me that this hernia of properitoneal fat usually occurs gradually as the result of everyday abdominal strains, and up to a certain point may gradually increase in size simply in virtue of fresh abdominal fat being forced down. Surgeons will no doubt have noticed how, when one of these fatty sacs is exposed, a pull on it will bring down more fat from the deep side of the crural ring.

This gradual development seems to explain how it is that the small fatty sac may remain undiscovered until it acquires contents. On the other hand, more rarely it may occur suddenly, as in the case mentioned above, where there was a sudden strangulation of properitoneal fat containing a peritoneal sac. The fatty sac lies in the tissues of the thigh as an inconspicuous flat swelling, smooth and soft, but quite typical, and easily recognized by palpation. As a rule it causes no pain or discomfort, and even the subject may be unaware of its presence until it acquires some contents.

The sac within the properitoneal fat is often small and not easily found by the uninitiated when for the first time he is called upon to operate on such a case. In fact the novice will often jump to the conclusion that the thin fascia which demarcates this properitoneal fat from the fat of the thigh is the peritoneal sac itself.

The sac will remain of moderate size until at last some omentum finds its way in. Once in, the omentum, I maintain, can never get out again, being a passive structure held in the tight grip of the neck. More and more omentum comes down into the sac, so that the neck and the sac become more and more distended. As the sac becomes distended its fatty covering becomes more and more thinned, until in a well-developed hernia the peritoneum may have only a very thin layer of fat covering it. Quite a different picture is then presented from that of the small empty fat-laden sac of the early stage.

It is interesting to note that hernia of properitoneal fat is accepted by many as the cause of the fatty ventral herniæ found on one or other side of the linea alba, usually above the umbilicus. To quote from Thomson and Miles' *Manual of Surgery*<sup>14</sup> in this connection: "A lobule of fat may be protruded through one of the spaces of the network. . . . As the plug of fat is further protruded it drags behind it a funnel-shaped process of peritoneum, which ultimately becomes the sac of a hernia". How much more likely is this to occur at the very dependent site of acknowledged abdominal weakness, the crural ring. It must, however, be admitted that Murray states<sup>15</sup> that these herniæ in the linea alba are of congenital origin, though not, of course, due to errant gubernacula.

**Relative Frequency of Femoral Hernia in Males and Females.**—If the active cause of both the original protrusion of the properitoneal fat with its peritoneal sac through the crural ring, and the passage of viscera later into the sac, is intra-abdominal pressure, it is evident that any condition which chronically increases the intra-abdominal pressure renders a person of any age or sex more likely to develop a hernia of properitoneal fat, or to acquire by the protrusion of viscera an actual in place of a potential hernia.

I think we may take it for granted that the shorter Gimbernat's ligament is, the broader will be the space between its free edge and the femoral vein, and therefore the more likely is the individual to develop a femoral hernia, potential or actual. But in view of Panton's work we must be careful not to make use of the size of Gimbernat's ligament in order to find a reason why the female is more liable to the development of a femoral hernia than the male. In relation to the relative sizes of Gimbernat's ligament in the two sexes, he says,<sup>16</sup> "the female average exceeds the male on the right side by 1 mm. only, and the left side measurements are in perfect agreement". He concludes, therefore, "that the sexual differences in the length of Gimbernat's ligament are negligible". Another point which he brings out is<sup>17</sup> that the "female false pelvis is either relatively narrower than the male, or else equal to it; it certainly is not greater". He also says, "the female Poupart's ligament is relatively shorter than the male". His actual figures are: modern male average (Poupart), 12 cm.; female, 11.8 cm. As the greater frequency of femoral hernia in the female has in the past been accounted for practically universally on the grounds that the female false pelvis is wider than the male, we must, in view of the results of Panton's painstaking research, readjust our ideas on the subject.

I have been studying some statistics prepared by Macready from the Clinic of the City of London Truss Society during the years 1888, 1889, and 1890, contained in his inspiring work<sup>18</sup> *A Treatise on Ruptures*. He calculates that between the ages of 21 and 65, the ages signifying when the rupture first appeared, the proportion of parous to non-parous women is as 3 to 1. Between these two ages we find in his complete tables 1037 women and 396 men suffering from femoral hernia. If to the female cases we apply the 3 to 1 proportion, we obtain roughly 778 parous women and 259 non-parous women. Therefore during the above three years we find the males have a majority of 137 over non-parous women. Of course we have to take another point into consideration—viz., how many of the parous women would have become ruptured even if they had not borne children. It is not easy to see how we can obtain this figure, but let us suppose it to be 20 per cent. This would mean that of the 778 parous women, 155 would have become the subjects of femoral hernia even if they had not had any children. Adding the 259 cases in non-parous women, we arrive at a total of 414, a majority of 18 over the men.

This juggling with figures may not be worth much, but I think that, coupled with Panton's findings, it is strongly suggestive of the idea that men are almost as liable to femoral hernia as women before they have had children, and therefore, that child-bearing is the one great factor which renders the female sex more liable to femoral hernia than the male. This is not surprising when one considers that for ten lunar months the intra-abdominal pressure is gradually increasing in a pregnant woman, and that this period is terminated by a still greater and more violent increase of pressure in the final act of expelling the child. It is true that for some part of the ten months the omentum and gut is kept away from the crural ring by the enlarged uterus; but what better conditions could be looked for than these for the pushing of properitoneal fat with the small peritoneal sac through the crural ring into

the thigh? One point, however, as far as I know, remains unexplained by any theory, and that is that among the comparatively few cases of femoral herniæ which occur before the age of puberty, about two-thirds occur in the female sex.

In 1911 I devised a method of treating the sac in the radical cure of femoral hernia, in which the sac was invaginated through the abdominal cavity and out through the anterior abdominal parietes well above Poupart's ligament. Here the sac was ligatured, cut off, and fixed. By this means the peritoneum and the properitoneal fat were drawn well up and away from the abdominal aspect of the crural ring. Having satisfied myself of the efficacy of this method by a three years' trial, I published it in 1914.<sup>19</sup> With a few slight modifications in technique, and with the assistance of a special invagination forceps made for me by Thackray, of Leeds, I still use this method entirely in cases of both simple and strangulated femoral herniæ. I devised this method when I was beginning to realize the possible bearing of the properitoneal fat in the region of the crural ring on the development of the femoral hernial sac, and also the influence which this fat might have in producing a recurrence of the condition.

### CONCLUSIONS.

1. That the sac of a femoral hernia is a pre-formed sac, and is not formed contemporaneously with the expulsion of a viscus.
2. That there is no sufficient proof that this pre-formed sac is of congenital or embryonic origin.
3. That the sac is acquired as a result of properitoneal fat being herniated into the thigh through that naturally weak site in man, the crural ring, and that this hernia of properitoneal fat drags with it a small peritoneal sac.
4. That anatomically a man is as much liable to a femoral hernia as a woman, and that the greater frequency of the condition in women is due to pregnancy and to the prolonged period of raised intra-abdominal pressure which that condition produces.
5. That no existing theory as to the etiology of femoral hernia accounts for the fact that among the comparatively few cases which occur below the age of 15 years, females have a two to one majority; but that this fact serves to throw doubt on the embryonic theory, in that normal physiological results suggest that the gubernaculum is a more active structure in the male than in the female.

Since writing this paper, I have been interested to see Mr. Russell's<sup>20</sup> short article in the *BRITISH JOURNAL OF SURGERY*, "Femoral Hernia, and the Saccular Theory". When he says, "During these years (1906 to 1923) I believe I may safely say that the saccular theory 'prevailed' and became firmly established among surgeons and surgical writers". I must confess that I am surprised and I think he is too optimistic in making the statement.

I note that he makes a strong point in reference to the direction taken "by a femoral hernia of any size after its emergence from the saphenous



opening", and he objects to the explanation often offered that the hernia follows the path of least resistance. He says, "the explanation becomes at once simple and obvious as soon as we recognize that the sac is a congenital structure". I fail to follow his reasoning, because it would seem to be obvious that in looking for the direction of the forces acting in bringing down the sac in the first instance, we must study the sac before it has changed its primary direction, as it does change it when it reaches the area of weakness in the deep fascia known as the saphenous opening. Now in my experience the direction taken by the sac before it has reached the saphenous opening is always downwards alongside the femoral vein, and therefore it would seem that without doubt the primary producing force, whether acting from above or below, must have been downwards. If the force had been produced, as Murray says, by the crural attachment of the gubernaculum, then one would have expected that the direction of the young sac would have been upwards and slightly inwards, namely, towards the point of exit of that strand of gubernaculum from the inguinal canal.

In reference to Panton's paper, Russell says that Panton has "clearly demonstrated the congenital origin of the femoral sac". I have read Panton's paper carefully, and I think that the above statement by Russell is too strong. What Panton has done is to make us readjust our ideas regarding the cause of the greater frequency of femoral hernia in women than in men, and realize that that cause is not a wider false pelvis, a longer Poupart's ligament, or a shorter Gimbernat's ligament. Regarding the question of whether there is a congenital factor in the etiology, he seems merely to review the existing evidence, especially as put forward by Murray, and to base his opinion on that without producing any additional evidence in support of the congenital theory. He certainly accepts the congenital theory, but, as I have said, I think that he does so too readily.

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- <sup>8, 9</sup> *Ibid.*, 59.
- <sup>10</sup> *Ibid.*, 63.
- <sup>11</sup> *Ibid.*, 65.
- <sup>12</sup> *Ibid.*, 74-79.
- <sup>13</sup> PANTON, J. ALLISON, "Factors bearing upon the Etiology of Femoral Hernia", *Jour. of Anat.*, 1923, Jan., lvii, Part 2.
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- <sup>15</sup> MURRAY, R. W., *Loc. cit.*, 83.
- <sup>16, 17</sup> PANTON, J. ALLISON, *Loc. cit.*
- <sup>18</sup> MACREADY, JONATHAN, *Treatise on Ruptures*, 1893, Tables I and II, pp. 6 and 7, Table XVI, p. 54.
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## THORACOSCOPY IN SURGERY OF THE CHEST.

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FOLLOWING the first use of the thoracoscope by Jacobæus some twelve years ago, thoracoscopy has become increasingly practised in the different European countries, and more especially in Scandinavia. It was primarily used as a method of diagnosis of the causative factors giving rise to exudative pleurisy, and only later developed into a means of treatment of pleural adhesions preventing pulmonary collapse in the treatment of pulmonary tuberculosis by artificial pneumothorax. This method of diagnosis and treatment has not, as yet, obtained much prominence in this country, and it is with a view to increasing its employment that this preliminary report is published.

**The Thoracoscope.**—Before proceeding to discuss the technique, it is advisable to give a brief description of the instrument.

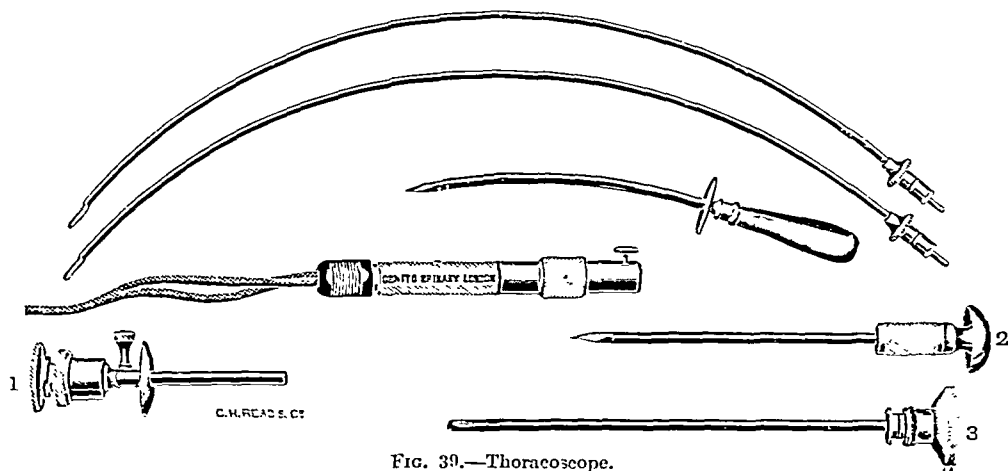


FIG. 39.—Thoracoscope.

The thoracoscope (*Fig. 39*) consists of a valved cannula (1), on the distal portion of which can be seen a shield, which, by adjustment of a small screw, can be varied in position; (2) is a simple trocar and cannula, the latter being to protect the point of the trocar in its passage through the valved cannula; (3) represents the telescope and terminal light, which also fits accurately the valved cannula. The remaining figures consist of the further instruments necessary for the cauterization of adhesions, and include two electric cauteries, the trocar and cannula for their introduction, and the connection and switch.

### Technique.—

**Preliminary.**—The operation of thoracoscopy depends for its performance upon the presence of a space between the parietal and visceral pleuræ, and

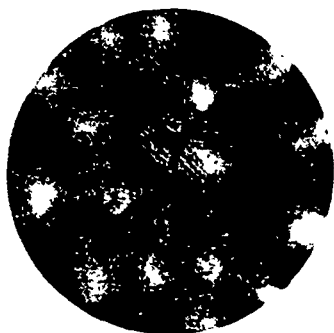


FIG. 40.—Normal lung (near view).



FIG. 41.—Normal pleura (near view).



FIG. 42.—Outer edge of lung, with inner surfaces of ribs and intercostal spaces in lower left segment.



FIG. 43.—Lower edge of lung, showing diaphragm to right and parietes below.

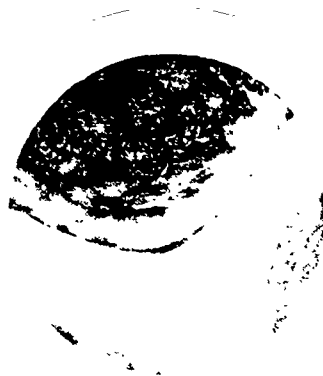


FIG. 44.—Outer inferior angle of lung above, diaphragm to right, and parietes below to left.

therefore, in those cases in which artificial pneumothorax has not already been induced as a method of treatment, its induction forms a necessary preliminary.

Where an effusion is present, the fluid is drawn off and replaced by gas.

The artificial pneumothorax can be induced by the introduction of oxygen, nitrogen, or air. The most common, from the point of view of treatment, is the introduction of air, previously filtered, but in cases where the induction is carried out solely for diagnosis or investigation it is advisable to use oxygen. In my opinion, there are two reasons for this: first, that, should it be necessary subsequently to perform thoracotomy, less difficulty will be found in obtaining rapid expansion of the lung, owing to the increased rate of absorption of oxygen in the meantime; secondly, the risk of gas embolism, at the first induction, is eliminated. Several inductions of gas will generally be required before the pleural separation is enough to give a comprehensive view.

Following the pneumothorax, skiagrams of the chest should be taken, preferably stereoscopic, in order to disclose any large areas of pulmonary adhesions and to indicate the most favourable site for the operation.

*Operation.*—This is preceded by an injection of omnopon, or of morphia, atropine, and hyoscine, and the skin of the chest wall prepared as for any surgical procedure.

The position of the patient upon the operating table is of some practical importance, as the facility of the operation is thereby increased. The patient is placed on his side, that side to be examined being uppermost, and a sandbag is arranged high under the lower axilla, and a pillow under the head. In this way the convexity of the spine towards the affected side is increased and the intercostal spaces are thereby widened.

The site of introduction of the thoracoscope will vary according to circumstances, but will necessarily depend upon two factors: (1) That it is necessary to introduce the instrument as near as possible to the area to be examined; and (2) That it is essential to be quite sure that it is not introduced into adherent lung. Both these points can be controlled by careful examination of the preliminary skiagrams. In general, the line just internal to the vertebral border of the scapula, after its rotation outwards by elevation of the arm, will be found suitable.

Having selected the site, the skin, subcutaneous tissues, and deep structures are freely infiltrated with novocain and adrenalin ( $\frac{1}{2}$  to 1 per cent). It is important, if the operation is to be carried out painlessly, that great care be taken to infiltrate down to and include the parietal pleura. The latter can be ensured in every case by steadily infiltrating as the needle is being thrust inwards until, on withdrawing the piston, gas comes freely into the barrel.

A small incision large enough to admit the trocar is made in the skin with a tenotome, the shield on the cannula is adjusted to the thickness of the chest wall, and the trocar and double cannula are thrust steadily through the intercostal space, into the pleural cavity. The trocar is then withdrawn and replaced by the telescope, and the cavity illuminated. The cannula is held with the shield firmly pressed against the chest wall and the telescope now moves freely inwards and outwards. By movement of the instrument



FIG. 45.—View of normal appearance of inner surface of chest wall, ribs, and intercostal spaces.

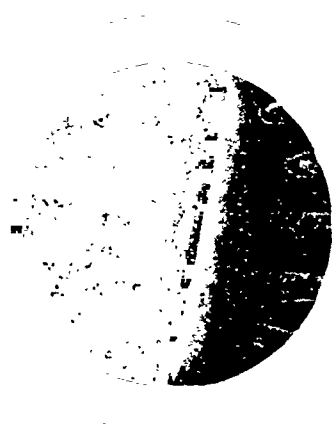


FIG. 46.—Distant view of outer edge of lung and chest wall.



FIG. 47.—Similar view to that in *Fig. 46*, but somewhat closer.



FIG. 48.—Site of needle punctures from gas refills: they appear as small vesicles.



FIG. 49.—Fibrous scar on surface of parietal pleura (? site of previous adhesion).

as a whole, lateral movement is obtained in addition, and by a combination of these movements the entire pleural cavity can be examined.

**The Normal Pleural Cavity.**—In the first place, it is important to remember that in all endoscopic vision the area under observation depends for its appearance on the distance of the prism of the telescope from the object and on the brightness of the illumination. Bearing this point in mind, it will naturally follow that the variation in appearances of structures in the large pleural cavity will be considerable—much greater than those of smaller cavities such as the bladder.

*Fig. 40* shows the characteristic appearances of the normal lung when a 'close-up' view is obtained. It will be seen to be of a pale-salmon colour, with irregular areas of dark pigmentation, varying from grey to black, scattered irregularly. Small vessels can be seen in or below the visceral pleura, and the whole surface glistens owing to the thin film of moisture covering it. As a whole the appearance closely resembles a highly-polished marble. Various portions of the lung can be recognized, and *Figs. 42, 43, and 44* show the outer edge, lower edge, and lower outer angle respectively.

On turning the telescope towards the parietes a close view of the pleura will appear, as in *Fig. 41*, where the surface is of a much brighter pink colour and distinct blood-vessels can be seen. The white patches represent the reflection of the lamp from the moist surface. A more distant view can be seen in *Figs. 45, 46, and 47*, where the inner surfaces of the ribs and intercostal spaces can be clearly defined.

Turning downwards, the view is as represented in *Figs. 43 and 44*, where the darkened area of the left lower portion represents the parietes somewhat poorly illuminated, with the diaphragm bulging up in the lower right portion. The division between these two structures is the phrenico-costal sinus, in which it is not uncommon to find a small quantity of fluid.

Owing to the crowding of the lung about the hilum by the gas displacement, it is not possible to see structures in this situation unless they project considerably beyond the normal lung.

**Pathological Conditions in the Pleural Cavity.**—The most common pathological conditions arising in the pleural cavity occur as a result of tuberculosis.

The first is due to actual involvement of the pleura itself by the disease. I have not had this condition drawn, but it is quite a typical picture. Both layers of the pleura are considerably congested; the areas of pigmentation are hidden by a fine layer of granulation tissue, scattered through which small typical greyish nodules can be seen.

The second variety consists in the formation of adhesions between the two layers of pleura, not uncommonly overlying the site of a tuberculous cavity in the lung. These adhesions can be divided for practical purposes into three main groups: (1) Large flat surface adhesions extending over a comparatively large area of lung surface and appearing through the endoscope as a fusion of the two layers. These are most common at the apex. (2) Thin film-like adhesions, which are comparatively narrow when viewed from one aspect, but much broader from the other. This type can be seen oscillating during the examination, often synchronous with the heart-beat. They are well illustrated by *Figs. 50 and 51*, showing the same band from two directions



FIG. 50.—Membrano-like adhesion stretching across field; attachments out of line of vision.



FIG. 51.—Same band as in *Fig. 50*, but from another view at right angles to the former.



FIG. 52.—Complete view of short band towards apex, with edge of another band at lower left corner.



FIG. 53.—Firm band-like adhesions, showing pulmonary and pleural attachments.

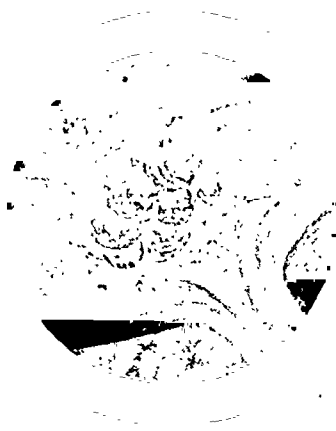


FIG. 54.—Pulmonary end of strap-like adhesion, with small mass of granulation tissue on lung above attachment, and parietes in distance.

at right angles to one another. (3) Longer or shorter strap-like adhesions, firm, pale, and fibrous-looking. These are almost invariably spread out at each end, with a slighter narrower waist towards the middle. They appear, and are, much more firm than the former variety, and show little or no movement. They are well represented in *Figs. 52, 53, 54*, and in the last is a small quantity of granulation tissue, probably representing the site of rupture of another adjacent band by the introduction of gas. *Figs. 48 and 49* are of some interest, the former representing the site of needle punctures which had been made to produce the artificial pneumothorax, the point of entry being now small cysts; and the latter a small area of scar tissue on the parietal pleura, possibly the site of a previously ruptured adhesion.

**Indications and Contra-indications.**—The method is indicated for diagnosis in all cases in which there is any real doubt as to the condition present in the pleura; for tumours growing from the pleura itself or projecting into the pleural cavity; and for the division of adhesions preventing collapse of the lung during the treatment of tuberculosis by artificial pneumothorax. This treatment is not considered in this communication.

The contra-indications consist of inability to induce a fairly considerable pneumothorax, and the presence of acute septic infection of the pleura. If performed for tuberculous empyema, great care must be taken, and the instrument should be introduced into the upper part of the pneumothorax cavity in order to prevent the subsequent formation of a fistula.

**Complications.**—The only complication, if such it may be called, that I have encountered, is the occurrence of a slight degree of surgical emphysema around the site of entry. The formation of a small quantity of fluid is quite common after induction of pneumothorax alone, and the frequency does not appear to be increased after thoracoscopy unless actual division of bands by the cautery is undertaken.

In conclusion, I should like to thank my medical colleagues at the Brompton Hospital for the opportunity of carrying out these investigations, and to express my indebtedness to Dr. P. L. T. Bennett, late Assistant Resident Officer, for his very excellent reproduction of the majority of the coloured drawings shown.



## TWO RARE BONE DISEASES: HEREDITARY DEFORMING CHONDRODYSPLASIA AND CHONDRODYSTROPHIA FŒTALIS.

By J. RENFREW WHITE, DUNEDIN, NEW ZEALAND.

THE three cases recorded and illustrated in this note have come under the writer's care within the last year. They have been considered worthy of record, partly because of the comparative rarity of the two diseases of which they are typical examples, but also because of the remarkable similarity of the clinical appearances presented in *Cases 1 and 3* by two diseases of bone growth the essential natures of which have been regarded as almost diametrically opposite.



FIG. 55.—*Case 1.* Deforming chondrodysplasia. Note the symmetrical outgrowths from the metaphysial parts of the humerus, and the lower ends of the radius and ulna; the deformity of the forearms, and the outgrowths from the ribs.

*Case 1.*—A case of deforming chondrodysplasia (multiple cartilaginous exostoses or diaphysial aplasia).

G. M., age 26, a farm labourer, was admitted to hospital on May 13, 1923, complaining of: (1) Multiple swellings in the neighbourhood of the joints of the limbs that have been present since childhood; (2) Limitation of the range of movement at the shoulders and in the forearms, noticed for the last few years; (3) Pain on movement of the shoulders, of a few weeks' duration.

§ HISTORY.—The swellings were first noticed when the patient was a child, but exactly at what age he cannot now say; they have been growing slowly ever since.



FIG. 56.—Case 1. Deforming chondrodysplasia. Note the enlargements of the lower end of the ulna in each forearm



FIG. 57.—Case 1. Deforming chondrodysplasia. Symmetrical cartilaginous outgrowths from tibiae and femora; valgus position of feet from relative shortness of fibulae.



FIG. 58.—Case 1. Skiagram showing the 'exostosis' from the humerus, the swellings on the ribs, and the irregularities on the vertebral border of the scapula.



FIG. 59.—*Case 1.* Showing the extraordinary outgrowths from the lower end of the ulna, actually invading the radius; the relative shortness of the ulna, with increased obliquity of the wrist-joint; the freedom from similar disturbances in the metacarpus.



FIG. 60.—*Case 1.* This shows well an 'exostosis' growing from the upper end of the femur, and the extraordinary mass of irregular outgrowth from the crest of the ilium from the anterior to the posterior iliac spine.

When 18 years of age, the swellings around the right knee and hip began to cause pain on walking, so that on Jan. 30, 1917, he was admitted to hospital, and the tumours were removed from these regions. During the last few weeks he has been getting similar pain on movement of the shoulders. Previous history was negative, and no other cases have been known in the family.

**EXAMINATION.**—The patient is quite healthy looking, but is a partial dwarf. height only 4 ft. 6 in. There are present hard irregular bony masses of various shapes and sizes projecting from the following parts of the skeleton: (1) From the postero-internal aspect of the upper end of each humerus is a lump the size of a cricket ball (*Figs. 55 and 58*). (2) At the lower end of each ulna, growing backwards and outwards towards the radius is a rounded mass producing mechanically great limitation of radio-ulnar movement (*Figs. 56 and 59*). (3) Fusiform swellings on the fifth, sixth, and seventh ribs in the mammary line (*Fig. 55*). (4) From the vertebral borders of the scapulae, which are concave instead of convex inwards. (5) From the crests of the ilia are projecting large irregular masses (*Fig. 60*). (6) There are scars at the hip-, knee-, and ankle-joints of the left leg: whilst in the corresponding parts of the other leg the exostoses are still present (*Figs. 57 and 60*). *Fig. 57* shows well the flat-foot resulting from permanent eversion of the ankle-joints due to the disproportionate lengths of tibia and fibula.

**OPERATION.**—On May 23, 1923, the large single mass projecting from the upper portion of each humerus was removed. These were slightly pedunculated; their summits were covered with bursae, and they were capped with a layer of cartilage; the rest of the masses were formed of soft cancellous bone. The pathologist reported them as 'ossifying chondromata'.

The most striking clinical characteristics of this case were:—

*a.* The symmetrical distribution of the outgrowths from the metaphyses of the long bones of the limbs that develop in cartilage.

*b.* The diminution of normal growth in length of the bones affected by the bony outgrowths; this has resulted in a stunting of the patient's growth in height, the condition of partial dwarfism.

*c.* This defect of growth in length, however, has not affected the long bones of each limb segment equally; both in the forearm and in the leg one of the two companion bones is shorter than the other. In the forearm the ulna is relatively diminished in length as compared with the radius, and ends in a curious 'arrow-head' lower extremity. It is noteworthy that, in addition, it is the ulna from which the bony outgrowths are chiefly growing (*Fig. 59*). In the leg the fibula is relatively shorter than the tibia, so that the plane of the ankle-joint is oblique and the foot is thrown into a valgus position.

*Case 2.*—A case of deforming chondrodysplasia in a boy of 7 years.

This is a case of 'multiple exostoses' in a schoolboy of 7 years. Here also there was no family history of similar cases. For a year or two his mother had noticed difficulty in fitting him with boots, on account of lumps forming on the outer sides of his ankles; but apart from this, he had suffered no disability. He came under the writer's observation owing to the detection of his disease by the school medical officer during a routine examination.

This case differs from the first in the involvement of metacarpals and phalanges in the same process of abnormal bone development (*Fig. 63*). In all other respects the only difference between the two cases is one of degree.

These cases, then, are well-marked examples of 'deforming chondrodysplasia'. Instances of this disease have apparently been noted for centuries, but it is only comparatively recently that attention has been specially directed

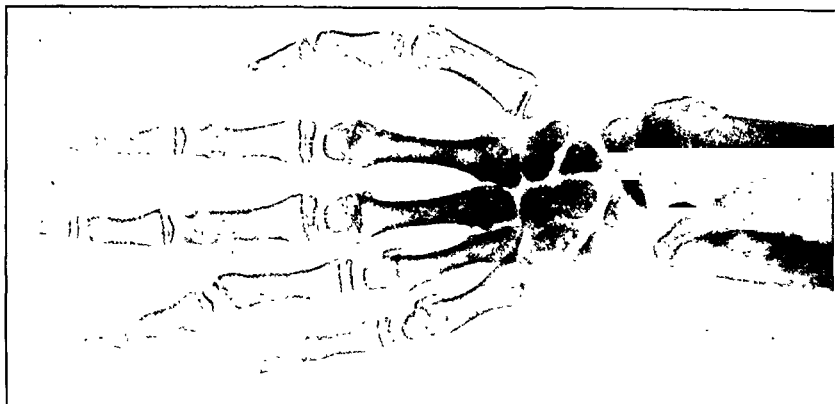


FIG. 63.—Case 2. Deforming chondrodysplasia affecting the metatarsals and phalanges as well as the lower ends of the radius and ulna.

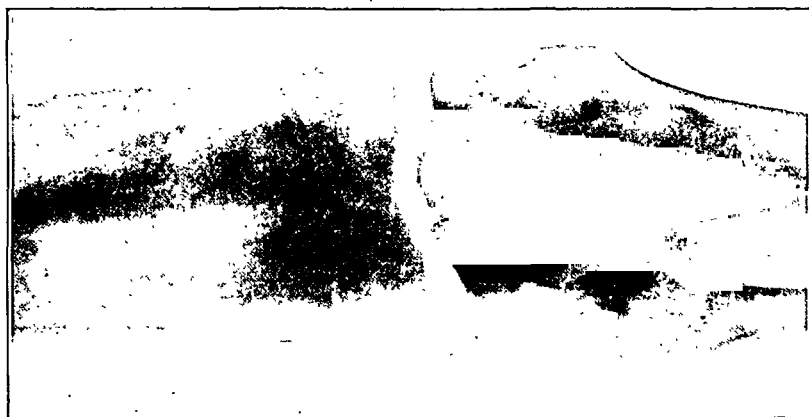


FIG. 62.—Case 2. 'Multiple exostoses' around knee-joint. Note the deformation of the head of the fibula.



FIG. 61.—Case 2. 'Multiple exostoses' around the knee-joint: lateral view.

to it as essentially a specific disorder of bone-growth, the exostoses being merely the most obvious clinical sign of a peculiar disorder of endochondral ossification.

As far back as 1853 Sir James Paget wrote: "The last form of bony growths that I shall mention comprises the instances in which numerous exostoses occur in the same patient. Of these last we may specially observe that the tendency to osseous overgrowth is often hereditary, and that its result is a symmetrical deformity. Many similar cases of symmetrical and hereditary osseous outgrowths might, I believe, be adduced; and all their history suggests that they are to be regarded clearly as related not less closely to malformations or monstrosities by excessive development than to the osseous tumours of which I have been speaking. Indeed, at this point the pathology of tumours concurs with that of congenital excesses of development and growth."

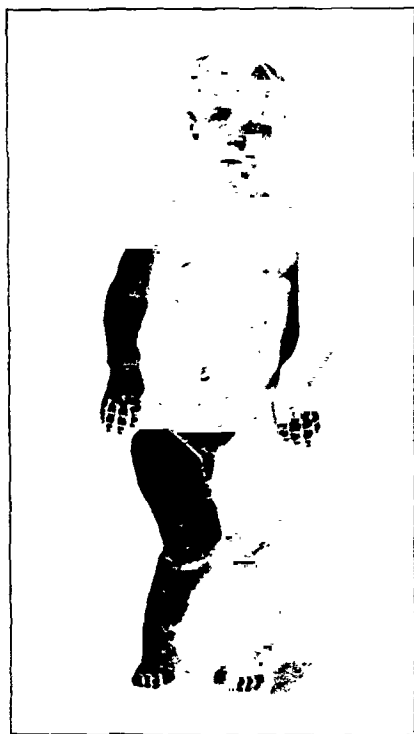
In 1915, in the *Journal of the American Medical Association*, Ehrenfried gave a summarized account of 600 cases collected from 300 individual communications. He established it as a specific clinical and pathological entity, different from a condition of multiple tumour-formation. He showed the frequency of its hereditary and familial occurrence, and gave it the name 'hereditary deforming chondrodysplasia'.

The skiagrams of this present case would certainly seem to prove that the condition is essentially one of irregular overgrowth in width of the diaphysial cartilages, possibly due, as Sir Arthur Keith suggests, to failure of the limiting action of the subperiosteal formation of bone.

**Case 3.—Chondrodystrophia fœtalis (achondroplasia).**

This patient, a boy of 11 years, was admitted to hospital because of progressive difficulty in walking owing to the bowing of the bones of his legs.

He appeared quite normal at birth, but he was late in walking. When he was four or five years old his legs began to bend. Three years ago his growth, which hitherto had been very slow, seemed to stop altogether as regards his limbs. When stripped and examined he presented a typical picture of achondroplasia (*Fig. 64*). His arms and legs are very short in proportion to his trunk and head. The bilateral knock-knee, the bent legs and arms, the epiphysial swellings, the short fingers with trident hand, the deformation of the chest wall, and the lordosis are all typical. In addition, he had marked permanent limitation of extension of both elbow-joints, with very great ligamentous laxity of wrist- and knee-joints.



**FIG. 64.—Case 3.** Achondroplasia with deformities of the bones of the legs, necessitating the performance of osteotomies.



FIG. 65.—Case 3. Chondrodystrophia foetalis. Marked arrest of endochondral ossification about the knee. The patella is well formed.

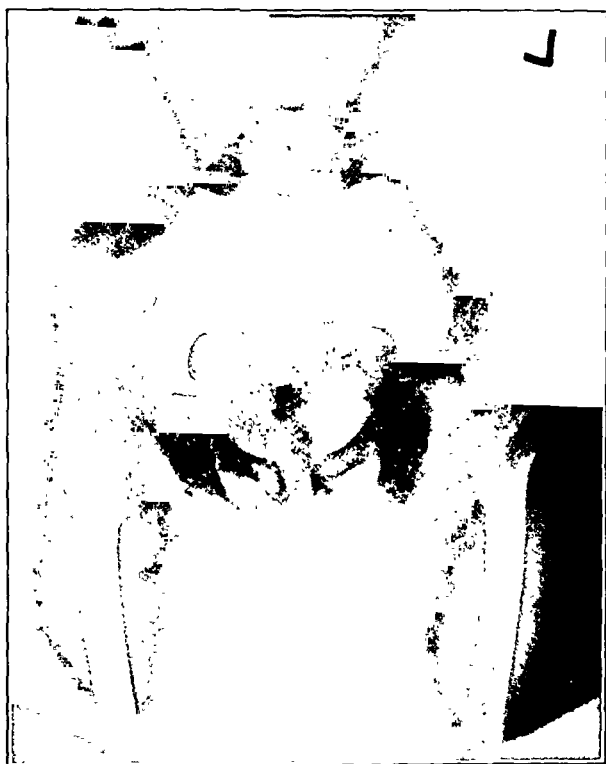


FIG. 66.—Case 3. Chondrodystrophia foetalis, showing changes in the femora and innominate bones.

If *Figs. 55, 56 and 57*, and *Fig. 64* be compared, close similarity of appearances is to be made out. Both cases present short limbs—a condition of partial dwarfism; bony swellings about the epiphysial levels of the long bones of the limbs; bending of the bones of forearm and leg; deformity of the chest, with prominent nodes at the junction of rib and costal cartilage:



FIG. 67.—*Case 3.* Chondrodystrophia foetalis, showing the affection of the bones of the forearms and the bones of the hands, both metacarpal bones and phalanges.

and limitation of full extension at the elbow-joints. The similarity in clinical appearance is remarkable in view of the absolutely dissimilar nature of the defect in bone development as seen by comparing *Figs. 58, 59 and 60*, with *Figs. 65, 66 and 67*.



## EXPOSURE OF THE HUMERUS AND FEMORAL SHAFT.

BY ARNOLD K. HENRY, DUBLIN.

THE following simple exposures of the humerus and femur seem to have escaped formal description, though doubtless the first has been used unconsciously by many. I have found them more satisfactory than the methods usually employed; they respect anatomy, give wide access, and save time.



FIG. 68.—Dissection of the right arm seen from the outer side. The uncovered outer fourth of the brachialis appears between the biceps and supinator longus, and extends behind the pointed deltoid insertion. It can be used as a buffer to protect the musculospiral nerve. The occasional small branch of the musculocutaneous to the brachialis muscle is shown.

A, Deltoid. B, Pectoralis major. C, Brachialis. D, Biceps. E, Cephalic vein. F, Occasional branch of musculocutaneous to brachialis. G, Supinator longus. H, Musculocutaneous nerve.

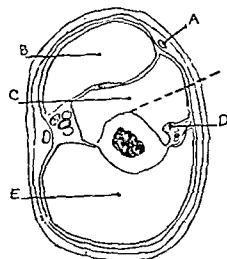
## THE HUMERUS.

Exposures as a rule define structures to avoid, or else avoid them completely: the method in question is a compromise. It lays bare the front of the humerus from end to end, leaving the musculospiral nerve protected and concealed; if further exposure is required, the nerve is directly available.

**Anatomy (Fig. 68).**—The *cephalic vein* follows the outer border of the biceps and the inner border of the deltoid, piercing the deep fascia in the lower third of the arm. It receives two or more tributaries on its outer side: these must be divided. The humeral branch of the thoracic axis artery accompanies the vein in the groove between the deltoid and

FIG. 69.—Cross-section through mid third of arm, showing the outer fourth of the brachialis left uncovered by the biceps belly. This part of the brachialis is split in the direction of the broken pointer to expose the humerus. The musculospiral is safe.

A, Cephalic vein. B, Biceps. C, Brachialis. D, Musculospiral. E, Triceps.



the pectoralis major, and gives branches to both muscles. The inner three-fourths of the wide *brachialis muscle* are covered by the *biceps belly* (Paulet): the way to the humerus here is through the uncovered outer fourth (Fig. 69). The *deltoid*, arising in front from

the edge of the clavicle's lesser curve, forms a thick unyielding curtain which gives, when pulled aside, a grudging revelation of the shoulder-joint. This is often the last successful thing it does.

The *cutaneous branch of the musculocutaneous* curves forward at the outer edge of the biceps just where the belly joins the tendon of insertion. One of its filaments is cut in the upper third of the forearm. An inconstant filament from the musculocutaneous described by Luschka and Henle, but neglected by many more recent authorities, supplies the outer fourth of the brachialis muscle in its distal part. I have found it three times in ten arms. The other branches to the brachialis are under cover of the inner portion of the upper half of the biceps belly.

The *musculospiral nerve* (the radial of the B.N.A.) runs deep in the plane of cleavage between the brachialis and the supinator longus (brachio-radialis of the B.N.A.). It reaches the outer side of the humerus one finger-breadth below the pointed insertion of the deltoid, and then curves very slightly forwards and down. Part of the nerve which lies behind the humerus is usually separated from the shaft by the pointed inner head of the triceps. The distal half of this retro-humeral portion, measuring a little more than an inch, is the only part of the nerve in direct contact with bone.

### The Operation.—

*Position.*—The patient lies with the limb close to his side and supported by the operating-table. The elbow is extended, and, when required, is flexed by an assistant.

*Incision.*—For exposure of the *shaft*, the skin incision (*Fig. 70*) follows the cephalic vein from the coracoid tip to the bend of the elbow, and is continued into the forearm in the mid-line of its upper third. The vein is exposed, and the outer edge of the biceps belly defined by dividing the deep fascia along its outer side.

Partial exposure of the bone may be obtained by shorter incisions, but these should never be short. Thus, to expose the distal part of the shaft, continue the incision well into the upper third of the forearm, dividing the deep fascia with blunt-nosed scissors to avoid injuring the radial artery and the cutaneous terminal (radial) branch of the musculospiral nerve: this division of the fascia allows wide retraction of the muscles.

Cut down on the humerus, first along the deltoid border; then divide the exposed outer fourth of the brachialis muscle longitudinally, a finger-breadth from the outer edge of the biceps. This cut is directed *inwards* to reach the humerus in the middle line (*Fig. 69*); it avoids Luschka's filament to the brachialis, and splits the muscle where its fibres are longitudinal. The



FIG. 70.—Cut through skin and deep fascia along the dotted line. (The arrow marks the 'step-down' at the acromioclavicular joint.) Expose (1) the deltoid attachment to the outer third of the clavicle, (2) the inner edge of the deltoid, and (3) the outer edge of the biceps. Continue the division of deep fascia throughout the upper third of the forearm. Split the brachialis as shown in *Fig. 69*.

outer strip of the brachialis, thus separated, forms a buffer which protects the musculospiral nerve from the rugine. The nerve is not seen if the front only of the humeral shaft is exposed, and the back too can be cleared safely while the nerve is concealed; but should the surgeon wish, the musculospiral can be found one finger-breadth distal to the deltoid insertion by further mobilizing the outer portion of the brachialis and retracting it outwards and back; the nerve then appears behind the upper fibres of the muscle, and the pull on the brachialis strip removes it just sufficiently from contact with the shaft to allow the rugine safe access to the bone. The nerve is most lax when the arm is adducted and the elbow flexed through  $80^{\circ}$ ; it is then most easily protected.

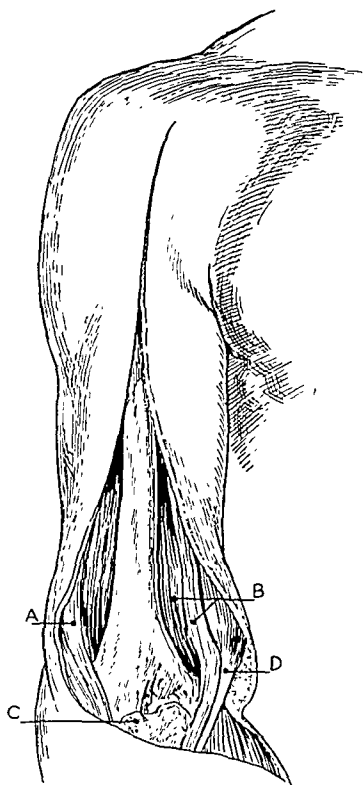


FIG. 71.—Separate the split brachialis from the bone; retract the inner and outer portions of the muscle. Relax it by flexing the elbow. The lower half of the bone is now exposed. In the figure the elbow-joint is opened and the coronoid process is seen. If exploration of the elbow-joint is not required, check the cut in the brachialis two finger-breadths above the epicondyles.

A, Brachialis (outer portion). B, Brachialis (inner portion). C, Coronoid process of ulna. D, Biceps tendon.

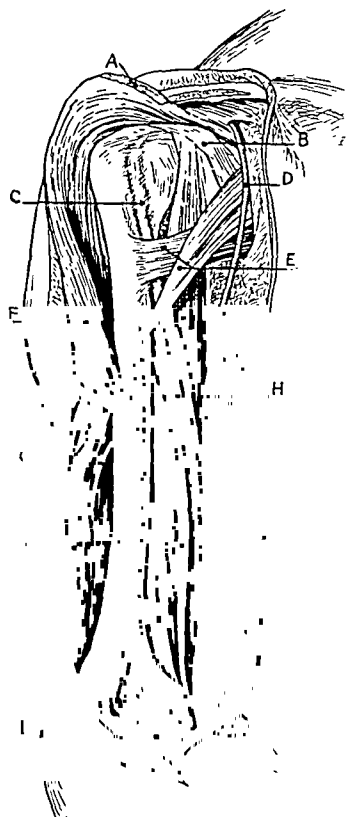


FIG. 72.—Complete the exposure of the humerus by turning the deltoid outwards on a hinged chip cut from the clavicle (*see also Fig. 73*). The musculospiral can be found, if required, by detaching the part of the brachialis which extends behind the deltoid tip.

A, Hinged chip of clavicle with deltoid origin. B, Coracoid process. C, Long head of biceps. D, Cephalic vein. E, Pectoralis major. F, Deltoid. G, Musculospiral. H, Biceps. J, Brachialis (outer portion). K, Brachialis (inner portion). L, Coronoid process.

The incision may be carried through the brachialis to within two finger-breadths of the level of the epicondyles, without entering the elbow-joint.

The bone seen through the split brachialis appears to lie at a considerable depth when the joint is extended. Flexion of the elbow to a right angle transforms this appearance, relaxing the muscle and leaving the bone widely accessible in a shallow wound (*Fig. 71*).

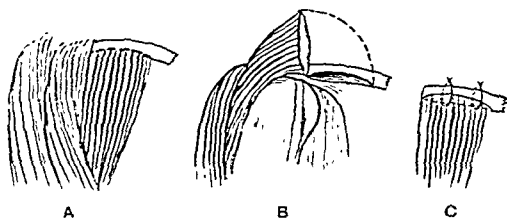
The front of the humeral shaft is now exposed in its entire length, completely in its lower half, but above, the deltoid yields insufficiently to retraction and gives a mere glimpse of the bone.

*The Shoulder-joint.*—This, with the upper part of the shaft and the tuberosities, can be exposed by continuing the skin incision outwards on the upper surface of the clavicle to the acromioclavicular joint, easily found by running the finger out along the clavicle; the finger takes, as it were, a step down at the joint (*Fig. 70*). Expose the deltoid origin by reflecting the skin. Divide the fascia and periosteum on the upper face of the outer third of the clavicle. With a chisel, detach the edge of bone which gives origin to the deltoid, as far as the acromioclavicular joint. The deltoid can then be turned outwards on a hinged piece of bone, like a sail on a spar (*Figs. 72, 73*).

When the shoulder-joint has been dealt with, sutures passed through the muscle and round the clavicle lash the spar back into place, and reconstitute the deltoid origin (*Fig. 73*).

*The Elbow-joint.*—This joint can be opened by extending the incision through the brachialis. The tip of the coronoid process and the trochlea are at once visible; the head of the radius and the capitulum appear with adequate retraction (*Fig. 71*).

When the operation on the bone is finished, extension of the elbow, before suturing the fascia, closes of itself the wide wound in the muscle.



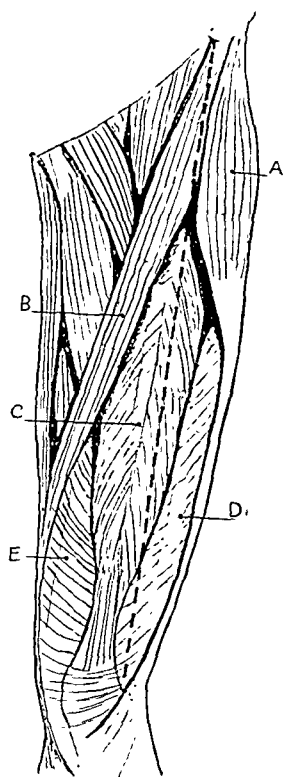
**FIG. 73.**—Cut the hinged chip from the clavicle along the line shown in A. B, Turn the deltoid out upon the hinged chip. C, Reconstitute the deltoid origin with two sutures which tie the chip back into place.

### THE FEMORAL SHAFT.

Exposure of the femur from the outer side of the limb is popular because it does not enforce reflection; the surgeon cuts down on bone with a feeling that the femorals are safe. The inconvenient, unsightly, and bloody wound suggests, however, that security has been attained at a price, and with a certain disregard for structure. The incision transects the oblique fibres of the vastus externus, the goal of four perforating arteries, and of the large descending branch of the outer circumflex; and unless the patient is maintained in a lateral position, the surgeon works in discomfort. The method described here respects anatomy, is almost bloodless, and gives a wide and convenient exposure. Over twelve inches of the shaft, from the level of the small trochanter to the lower epiphysis, are freely available: the surgeon looks directly down on the front of the bone, and can see both sides of it in comfort.

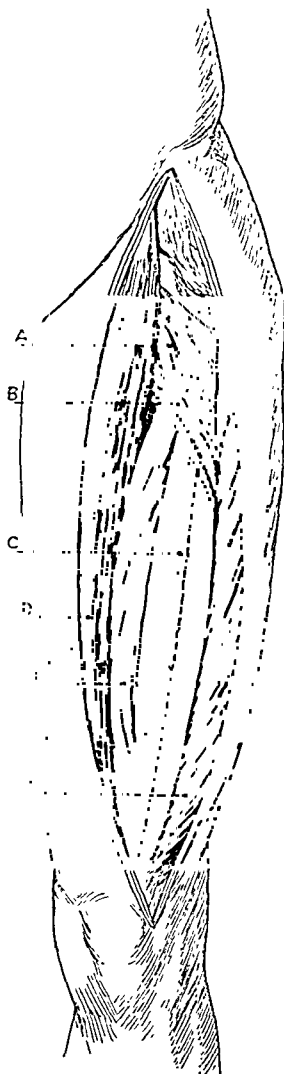
**Anatomy.**—The strong fascia of the thigh is loosely attached to the thin sheaths of the rectus femoris and vastus externus. When it is divided the upper two-thirds of these muscles are easily separated by the finger, which finds the intervening plane of cleavage most easily a hand-breadth below the great trochanter (*Fig. 74*).

Near the patella the aponeurotic fibres of the vastus fuse with the rectus tendon, preventing further separation by the finger. When the rectus femoris and vastus are retracted, the silvery surface of the crureus (vastus intermedius of the B.N.A.) (*Fig. 75*) appears, and separation of its longitudinal fibres reveals the femoral shaft.



**FIG. 74.**—Cut through skin and fascia along the dotted line, from the anterior superior spine of the ilium to the outer angle of the patella. Find the plane of cleavage between the rectus femoris and vastus externus one hand-breadth below the great trochanter, where the rectus sinks into the angle between the sartorius and the tensor fasciæ.

A, Tensor fasciæ. B, Sartorius. C, Rectus femoris. D, Vastus externus. E, Vastus internus.



**FIG. 75.**—Separate the rectus femoris from the vastus externus, exposing the crureus, which is crossed obliquely by a neurovascular bundle (the descending branches of the external circumflex vessels and the nerve to the vastus externus). The artery shown above the nerve is the transverse circumflex branch lying in front of the neck of the femur.

A, Nerve to vastus externus. B, Descending branch of external circumflex artery (with veins). C, Crureus. D, Rectus femoris. E, Vastus internus. F, Vastus externus.

Two structures must be considered before the bone is exposed. The first is an oblique neurovascular bundle which consists of the descending branch of the external circumflex artery, its companion veins, and the nerve to the vastus externus. This bundle is found a hand-breadth below the trochanter. The second structure, the suprapatellar pouch, extends for the same distance above the pointed extremity of the patella. As each of these must be specially dealt with by the surgeon, they will be further described with the operation itself.

### The Operation.—

*Incision.*—The skin and deep fascia are divided along a line from the anterior superior iliac spine to the outer angle of the patella (Fig. 74).

*Planes of Cleavage.*—The finger finds the interval between the rectus femoris and vastus externus, a hand-breadth below the great trochanter, and the muscles are separated by means of the finger, which may meet one or two vessels passing to the rectus; these are caught and divided. In the lower third of the thigh the finger is checked where the aponeurotic fibres of the vastus join the rectus tendon, and the knife must be used to separate them. The blade is kept parallel to the face of the quadriceps tendon, and a plane of cleavage will be found in this trilaminar structure, between the contribution from the rectus and that from the vastus, which permits their separation down to the patella. In septic conditions, however, the laminæ of the quadriceps tendon should not be separated beyond a level one hand-breadth proximal to the apex of the patella. A small protrusion of the suprapatellar pouch sometimes pierces the tendinous contribution from the vastus externus below this level, and may be sliced open. The synovial cavity of the knee might thus be infected. When the two muscles are mobilized and drawn apart they expose the silvery surface of the crureus.

*The Neurovascular Bundle.*—The oblique descending branches of the

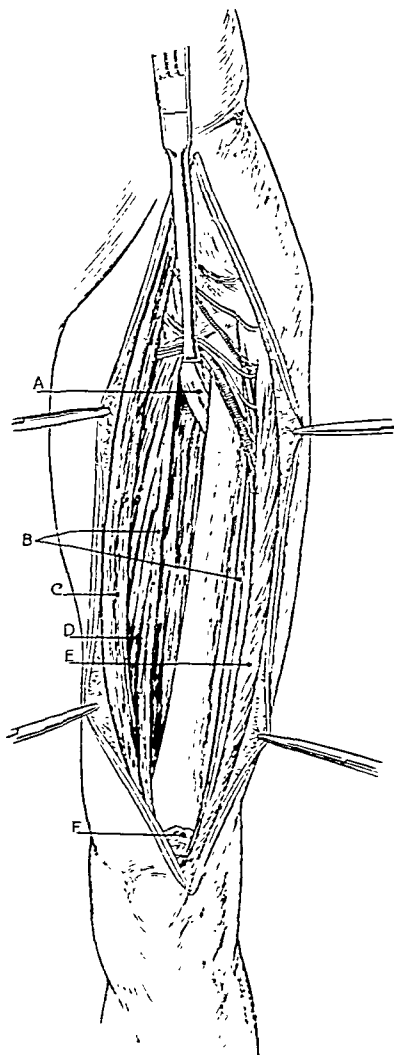


FIG. 76.—Mobilize and retract the neurovascular bundle. Split the crureus along the dotted line shown in Fig. 75. Avoid the suprapatellar pouch by checking the cut through the crureus one hand-breadth proximal to the pointed end of the patella.

A. Iliopsoas insertion. B. Crureus (split). C. Rectus femoris. D. Vastus internus. E. Vastus externus. F. Suprapatellar pouch.

external circumflex vessels and the nerve to the vastus externus are now seen passing across the crureus from beneath the rectus femoris to strike the free edge of the vastus externus, into which they sink. They run in a streak of fat, roofed by thin fascia, and are easily mobilized by drawing a knife along its lower edge; they are retracted proximally (*Fig. 76*). The surgeon can then cut to the bone through the upper portion of the crureus.

A large vein is often divided in this part of the muscle.

*The Suprapatellar Pouch.*—This, extending a hand-breadth above the apex of the patella, is easily avoided by checking the cut through the crureus above this level. The rugine works against the bone in a layer of fat, and separates the pouch from the femur.\* If necessary, a retractor can be slipped between the pouch and the bone, and flexion of the thigh, relaxing the quadriceps, gives access to the lower end of the shaft.

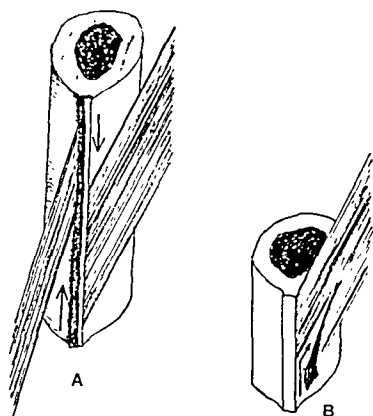


FIG. 77.—Work the rugine into the acute angle A which the muscular attachments make with the bone. B shows how the rugine tears into a muscle when used in the reverse direction against the obtuse angle.

When the two halves of the split crureus are separated from the bone and drawn apart, over a foot (32 cm.) of the femoral shaft is exposed—from the lower epiphysis to the lesser trochanter. At the inner side of the shaft the attachment of the muscles to the linea aspera is visible. If it is necessary to clear the linea aspera, the direction of the fibres should be noted; the edge of the rugine should travel into the acute angle which they make with the bone. If the rugine is used in the opposite direction, it tends to leave the bone and tear into the muscle (*Fig. 77 B*). The direction of the muscle fibres varies, of course, at the same part of the bone.

Thus the adductors travel down *to* the femur, while the vasti and short head of the biceps travel down *from* the femur. These attachments are cleanly separated by proceeding with method.

The surgeon should begin on the inner side of the linea aspera. The thin origin of the vastus internus which constitutes the internal intermuscular septum (Poirier) is easily seen, and is detached from the linea aspera by working the rugine up along the shaft. The adductor insertions which form the next layer are then separated by using the rugine in the reverse direction.

On the outer side of the shaft the rugine is worked up against the origins of the vastus externus and short head of the biceps. The strong external intermuscular septum should be dealt with last; its lowest fibres are irregularly arranged, but its attachment to the linea aspera can be exposed to view by

\* Attempts at separating the pouch from the quadriceps tendon will as a rule tear the pouch. (The pouch, of course, communicates with the knee-joint.)

drawing the vastus externus towards the back of the thigh. If the surgeon then seats himself for a moment with his eyes level with the wound, the perforating vessels will be seen coming through the arched openings of the septum ; and since the vessels are drawn backward in these roomy arches by retracting the muscles, they will not be injured when the septum is cut close to the bone.

Counter-openings for drainage may be made with perfect safety by cutting down on the tip of a forceps passed between the outer moiety of the crureus and the bone. The forceps follows the outer face of the external intermuscular septum, and since, in the recumbent posture, this septum is almost vertical to the bed, drainage is excellent.

In conclusion I wish to express my thanks to Professor E. J. Evatt, D.S.O , for the opportunity of working out these methods in the Royal College of Surgeons, Ireland, and to Mr. M. Barry, of the School of Art, Dublin, for his drawings of the operations.



## A CAUSE FOR THE FREQUENT OCCURRENCE OF GANGRENE AFTER LIGATURE OF THE POPLITEAL ARTERY.

By JOHN S. B. STOPFORD, MANCHESTER.

THE frequency of the occurrence of gangrene after occlusion of the popliteal artery is well known, and only recently Sir George Makins<sup>1</sup> has stated that "injuries to the popliteal vessels enjoy a more evil reputation than those affecting any other artery of the limbs"; yet the reason for this is by no means clear. Many ingenious explanations have been advanced at various times, but a vague reference to the inefficiency of the collateral circulation is the reply most commonly received to any inquiry as to the cause for the very serious risk of gangrene after obstruction of the popliteal artery. This explanation appears to be inadequate, and particularly unsatisfactory when it is recalled that gangrene is much less frequent after ligature of the superficial femoral artery, although following this procedure the distal part of the limb must depend upon practically the same anastomoses. Makins records gangrene in 20·4 per cent after ligature of the superficial femoral, and in 45·8 per cent after injury to the popliteal.

An anatomical explanation for the very frequent incidence of gangrene consequent upon popliteal obstruction has for some time interested me, and an opportunity of studying a patient suffering from this condition, through the kindness of my colleague, Professor E. D. Telford, suggested that I should place it on record.

The patient was an electrician, age 50, who had never previously, to his knowledge, suffered a day's illness. He first came under Dr. P. R. Cooper's observation on account of the appearance of dry gangrene in the left foot and toes. There had been an absence of pain, and there was nothing to suggest a cause for the obvious arterial obstruction. The Wassermann test was negative, no evidence was discovered of cardiac or renal disease, and the blood-pressure was not raised.

After amputation through the lower third of the thigh, Professor Telford kindly permitted me to make a full examination of the limb. On opening the popliteal space an abnormal amount of fibrous tissue was encountered in the deeper part, and the vessels could not be cleared with the customary ease, which suggested some peri-arteritis. A complete obstruction of the popliteal artery, about three-quarters of an inch in length, was found at the level of origin of the inferior articular branches, and the orifice of each of these vessels was absolutely occluded. Microscopic sections through the obstructed part of the popliteal artery demonstrated the cause to be thrombosis; but histological examination of the popliteal above the level of the lesion, the superficial femoral, and the anterior tibial arteries, failed to reveal any reason for the formation of the clot.

It is difficult at first to understand the reason for the onset of gangrene consequent upon a localized, and probably gradually formed, obstruction of the popliteal artery in a patient with otherwise healthy vessels. Reference to the possible collateral circulation (*Fig. 78*) seems to suggest the only serviceable explanation. After occlusion of the popliteal artery, the blood passes from above to the patellar anastomoses through the descending branch of the external circumflex, the anastomotica magna, and more indirectly through

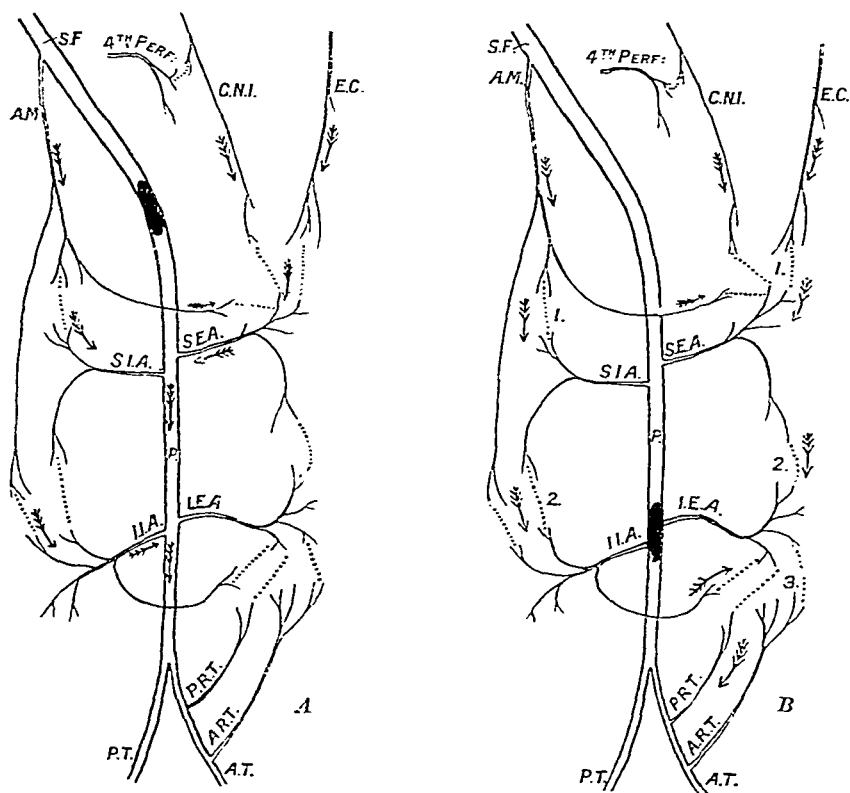


FIG. 78.—Diagrams to illustrate collateral circulation after obstruction of the popliteal artery (*A* in upper third, and *B* in lower third). S.F., Superficial femoral artery; P., Popliteal artery; P.T., Posterior tibial artery; A.T., Anterior tibial artery; E.C., Descending branch of external circumflex artery; A.R.T., P.R.T., Anterior and posterior recurrent tibial arteries; S.I.A., S.E.A., Superior internal and external articular branches; I.I.A., I.E.A., Inferior internal and external articular branches; A.M., Anastomotica magna artery; C.N.I., Comes nervi ischiadici branch of sciatic artery; 4th Perf., Fourth perforating artery. 1, 2, 3. The three sets of arterial communications which have to be 'opened up' when obstruction occurs in the lower part of the popliteal artery.

the comes nervi ischiadici branch of the sciatic and the perforating arteries. If the obstruction occurs distal to, or at the level of, the origin of the articular branches of the popliteal, the blood can only reach the leg and foot by traversing the two recurrent branches of the anterior tibial artery. Since the latter vessels only anastomose to any extent with the inferior articular branches, the blood coming from above, in order to reach the distal

part of the limb, has to open up the fine communications between (a) such vessels as the anastomotica magna and the superior articular branches; (b) the superior and inferior articular branches; (c) the inferior articular branches and the recurrent tibial arteries.

This means that to provide a collateral circulation, *three* anastomoses in succession must really be opened up, and in view of this it appears less surprising that injuries to the popliteal artery are so commonly succeeded by gangrene. In fact, when the small size of the normal recurrent tibial arteries is also recalled, and the frequent irregularity of the posterior one remembered, it seems more surprising that sufficient blood to maintain the life of the tissues ever reaches the foot after ligature of the lower part of the popliteal artery.

After ligature of the superficial femoral or popliteal above the level of the origin of the superior articular branches, only one set of anastomotic communications have to be opened up, since the blood can reach the popliteal through the main stems of the superior articular branches and pass by normal channels to the leg and foot.

The figures collected by Makins thoroughly support the view put forward in this paper, as he discovered that, in injuries to the popliteal artery, the situation of the wound considerably influenced the occurrence of gangrene. In 60 cases he found gangrene in 20 per cent when the injury affected the upper third (which is most probably above the origin of the superior articular branches), in 40 per cent in the middle third, and in 35 per cent in the lower third. These percentages show—as my explanation would lead us to conclude—that the occurrence of gangrene is only as frequent after obstruction of the upper third of the popliteal artery as after obstruction of the superficial femoral, but if the course from the articular branches through the popliteal to the anterior and posterior tibial arteries is impeded, the risk of gangrene is very markedly increased.

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#### REFERENCE.

- <sup>1</sup> MAKINS, G. H., *On Gunshot Injuries to the Blood-vessels*, John Wright & Sons Ltd., Bristol, 1919.

# 'MESENTERIC CYSTS': WITH A REPORT OF TWO CASES.

By T. TWISTINGTON HIGGINS AND ERIC I. LLOYD, LONDON.

THE first known case of a mesenteric cyst was described by Benevieni, the Florentine anatomist, in the 16th century. Since that time about 250 cases have been published, chiefly by surgeons. These cysts are found rarely, and their etiology is so uncertain that it seems worth while to record the following example which occurred recently in the hospital practice of one of us (T. T. H.). The opportunity has been taken to describe at the same time a second case which, though clinically very different, presents points of similarity to the first which we think suggest a close relation between the two, or at least constitute a useful parallel. We propose to describe these cases in detail, to give a short summary of current views on the etiology, symptomatology, and treatment of mesenteric cysts, and to discuss the relationship between the two cases and such views.

## CASES.

*Case 1.*—C. O., a boy, 5 years old, was admitted to the Hospital for Sick Children, Great Ormond Street, on May 24, 1923, suffering from an undiagnosed abdominal swelling. The history given by his parents, who were well educated, was that the child was 'perfectly well' until three weeks before admission, when a swelling was accidentally discovered in the left side of the abdomen. This swelling was entirely symptomless, and they had noticed no change in the child beyond slight irritability and a tendency to tire easily. His appetite was normal, he was not getting thinner, and there was nothing to suggest implication of the alimentary or urinary tracts.

ON EXAMINATION.—The child was normal except for his abdomen, which was enlarged asymmetrically. A very large mass could be felt occupying the whole of the right side of the abdomen, passing across the mid-line into the left umbilical and lumbar regions. It was distinct from the liver and spleen, and its surface was smooth. It felt tense, but not definitely cystic, and was immobile. The swelling was painless on examination, and dull on percussion, except where intestine lay in front of it. X rays demonstrated a retroperitoneal tumour pushing the intestine forward, but nothing abnormal could be felt per rectum, and the blood and urine were normal. Dr. R. S. Frew reported that the heart and lungs were also normal. An exact diagnosis could not be made, but a sarcoma of the right kidney and an encysted tuberculous peritonitis were considered possible.

OPERATION.—Exploratory laparotomy was carried out (T. T. H.) on May 31, and the swelling exposed through a right rectus incision. During the operation 14 oz. of citrated blood were given intravenously. The swelling was found to be a very large unilocular cyst lying retroperitoneally behind the termination of the superior mesenteric artery; this artery and its accompanying vein were stretched across the cyst, which lay between the ascending colon on the right and the small intestine on the left (*see Fig. 79*). Complete removal was obviously impossible, so the cyst was tapped, and 35 oz. of turbid brown odourless fluid, shimmering with cholesterol crystals, were removed. Below the main cyst and in the ileocaecal angle of the mesentery were many thin-walled smaller cysts the size of a split pea and

containing a clearer fluid. These were probably simple dilated serous spaces in the mesentery caused by the pressure of the tumour. It was decided that marsupialization was the only feasible method of treatment. Accordingly the cyst wall was freely incised, the contents were completely evacuated, and the cavity was sponged out with gauze; finally the edges of the opening were accurately sutured to the lower half of the abdominal wound. A large drainage tube was inserted into the cavity of the cyst, and the upper half of the abdominal wound was closed in the usual way. At subsequent dressings the cavity was plugged with gauze soaked in flavine in liquid paraffin in the hope of inducing intracystic adhesions.

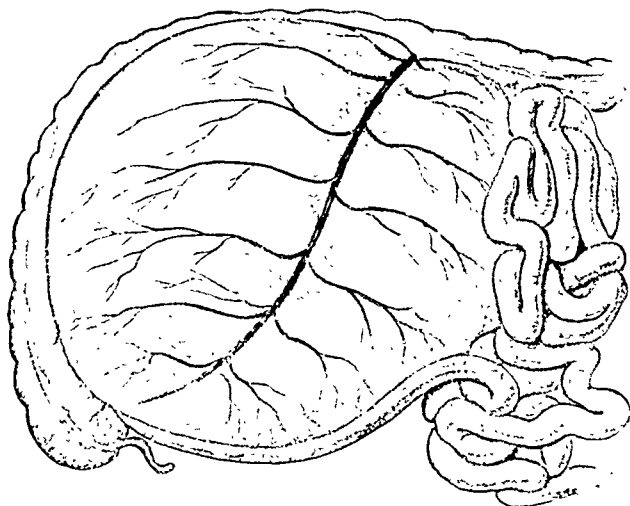


FIG. 70.—Mesenteric cyst (diagrammatic).

The child made an uninterrupted recovery, and was discharged on July 30. He was seen a month later, and was then quite well; the wound was firmly healed; there was slight thickening to be felt beneath the scar, but the abdomen was otherwise normal on palpation. He was seen again in April, 1924, when his condition was excellent.

**PATHOLOGY.**—The fluid removed from the cyst showed the characters usual in these cases, and the report was as follows: "Very bloodstained, specific gravity 1217, no trypsinogen, etc., no sugar or bile pigment, albumin present more than 4 per cent". The sediment was chiefly blood, and the fluid was sterile on culture. A section of the cyst wall showed "a thick wall of fibrous tissue with an endothelial lining".

The features we wish to emphasize in this case are: the large size of the tumour, its lateral position and immobility, the doubt whether it was solid or cystic, and the presence of secondary smaller cysts.<sup>1, 2, 3</sup> In other respects it was true to type, even in that a correct diagnosis was not made before operation.

**Case 2.**—(We are indebted to Mr. H. J. Waring for permission to publish this case.) C. C., a married woman, 45 years of age, was admitted to St. Bartholomew's Hospital on Jan. 28, 1921, with a history that eighteen years previously she had noticed a lump in the abdomen. This was said to have been diagnosed as oöphoritis; the swelling was thought to have disappeared, and the patient remained quite well until 1911, when the swelling reappeared. In August, 1920, there was a sudden

increase in its size, accompanied by discomfort but not by acute abdominal pain : there were never any urinary symptoms ; she had complained of irregular menstruation with increased loss since 1911.

**EXAMINATION.**—On inspection of the abdomen there was a visible swelling in the right hypochondriac and right lumbar regions, the size of an ostrich's egg. It was fluctuant, there was a band of resonance between it and the liver, and on palpation the swelling could be distinguished from the liver. Although cystoscopy showed both kidneys to be working normally, it was thought that she was suffering from a right-sided hydronephrosis.

**OPERATION.**—On Feb. 1, 1921, an exploratory operation was performed through a right lumbar incision by Mr. Harold Wilson. A large cystic swelling was found lying in the perinephric tissue in relation to the upper pole of the right kidney. It was not attached to the kidney or suprarenal body, and lay outside the tunica propria of the former. Seven pints of greenish-brown fluid were evacuated through a cannula, and the cyst wall was dissected out and removed. The wound was drained for twenty-four hours, and was healed when the patient left the hospital three weeks later.\*

**PATHOLOGY.**—A section of the cyst wall showed "purely inflammatory structure with no evidence of renal tissue". The fluid removed at operation possessed a greasy sheen and contained cholesterin crystals. Its specific gravity was 1020, the reaction was neutral, and the fluid coagulated spontaneously on standing. On culture it proved to be sterile. It contained red blood-corpuscles and a considerable quantity of albumin, and effervesced with sodium hypobromite.

Although the last statement is evidence of the presence of urea, it does not prove that the fluid in the cyst was derived from urine : it is well known that the blood, cerebrospinal fluid, saliva, and probably most of the other body fluids contain urea, but that the percentage in urine is five to ten times that in the blood (20 to 40 mgrm. per cent in health). We have no quantitative figures on the interesting question whether the cyst contents were in this respect nearer blood or urine, nor has this point been investigated, so far as we know, in other cases. The only observation we have found in this relation is that of Jones,<sup>1</sup> who found urea 0·3 per cent in fluid from a mesenteric (not pararenal) cyst. This is, approximately, the same as in blood. The case we have described was labelled 'pararenal cyst', but its exact pathology remained in doubt.

## GENERAL REMARKS ON MESENTERIC CYSTS.

### ETIOLOGY.

**What is meant by the term Mesenteric Cyst?**—It often happens, when a condition of obscure origin is under consideration, that the nomenclature and classifications in general use are as diverse and unsatisfactory as the attempts to explain the disease, and it is certainly so with mesenteric cysts. Broadly speaking, any cyst occurring between the layers of, or in close relation to, the mesentery might be included under the heading 'mesenteric'. Thus, many of the published classifications embrace a variety of cysts (e.g., hydatid, malignant, and dermoid) whose only common attributes are their cystic character and intramesenteric position. Hæmatomata of the mesentery, which

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\* On Nov. 11, 1923, the patient wrote that she was perfectly well.

may follow injury in the absence of a pre-formed cyst, certainly account in rare instances for mesenteric tumours, but they are not true mesenteric cysts and only call for consideration in differential diagnosis. Such adjectives as lymphatic, chylous, sanguineous, though frequently used, merely denote accidents which may befall any cyst, and though picturesque they have no precise bearing on the problems of etiology and serve no useful purpose. It is therefore necessary to extract from the general mass common to all classifications the group of what may be called 'true' mesenteric cysts, for it is with this group only that we are now concerned. Before proceeding to this, it is convenient to consider some of the classifications which have been suggested, and three of the simpler and more recent of these are given below.

1. In 1900 Dowd<sup>5</sup> published an important paper and adopted the following :—

- a.* Embryonic cysts.
- b.* Hydatid cysts.
- c.* Cystic malignant disease.

This was amplified by Ayer,<sup>6</sup> who added two more groups :—

- d.* Cysts arising from the glandular structure of the intestinal wall.
- e.* Cysts of the normally placed retroperitoneal organs.

2. Niosi<sup>6</sup> in 1907 subdivided Dowd's embryonic group thus :—

- a.* Cysts of intestinal origin : By sequestration from the bowel during development ; From Meckel's diverticulum when it arises from the concave side of the gut.
- b.* Dermoid cysts.
- c.* Cysts which spring from retroperitoneal organs (e.g., germinal epithelium, ovary, Wolffian or Müllerian bodies).

3. A more recent classification, that of Carter,<sup>8</sup> though evidently based on Dowd's, is as follows :—

- a.* True mesenteric cysts : Embryocystomata ; Enterocystomata ; ? Obstructive.
- b.* Dermoids.
- c.* Cystic malignant disease.
- d.* Parasitic.

We are not here concerned with parasitic or cystic malignant disease, and they may be dismissed. So also may true dermoids ; but it is interesting to notice in passing that no retroperitoneal or mesenteric dermoids have been reported in the male,<sup>6,9</sup> though they have occurred in the testis,<sup>6</sup> which is originally a retroperitoneal organ ; this has been held as evidence that an ovary is responsible for the true dermoid when it occurs in the mesentery.

**True Mesenteric Cysts.**—We have now restricted our field to those cysts which occur in or near the mesentery and which are not malignant, dermoid, or parasitic, and do not arise in any normally placed retroperitoneal organ. It is to the origin of these that we must now turn our attention. They have been found at every time of life, from the fœtus to 80 years of age, though most commonly from 10 to 20 years, and occur in both sexes, with a slight preponderance of female over male. They are usually found

near the terminal portion of the ileum, though they have also been described in the mesentery of the jejunum, the cæcum, and appendix, and all parts of the colon; at least one occurred in close relation to the stomach.<sup>10</sup> Of 28 cases published between 1900 and 1912, all were in the mesentery of the small bowel, with a proportion of ileum to jejunum of about 3 to 1.<sup>11</sup>

The cyst often possesses an epithelial lining, though this is by no means invariable, and in a large cyst is frequently destroyed, presumably by the internal pressure exerted upon its walls; in one specimen the lining epithelium remained only here and there.<sup>12</sup> When present it is generally of simple columnar type, but may be stratified, or rarely ciliated.<sup>11</sup> The wall of the cyst varies in thickness and composition; fibrous tissue predominates, but there may be a few unstriated muscle fibres or occasionally a complete reproduction of the structure of some part of the alimentary tract (*vide infra*). The typical fluid<sup>13</sup> from a mesenteric cyst is "a pale, clear, straw-coloured fluid of specific gravity 1015 or 1016, contains a large amount of albumin, and is alkaline in reaction". Blood, cell debris, and cholesterin are also usually present. Multiple cysts are rare, though cases have been recorded, by Makins<sup>1</sup> amongst others.

What is the origin of these cysts?

1. LYMPHATIC.—For many years the accepted idea was that they arose from obstruction and subsequent dilatation of a lymph-vessel in the mesentery. This view has been largely discarded in England and America, but, until recently, had its adherents in France.<sup>13, 14</sup>

2. WOLFFIAN REMNANT.—In 1900, Dowd<sup>5</sup> reintroduced and elaborated the suggestion that these cysts are due to inclusion of remnants of the Wolffian body in the developing peritoneal folds. Eight years previously, Braquehay<sup>15</sup> had stated that "they" (i.e., congenital mesenteric cysts) "may come from rests of the Wolffian body", and had referred as authority to Auganeur's *Thèse d'Aggrégation* (Paris, 1886); but it was Dowd's paper that focused attention upon the subject. Dowd gave instances of sequestration in many organs, and concluded that these cellular relics behind the peritoneum might push their way between the leaves of the mesentery, and—liable as they are to undergo cystic degeneration—might give rise to cysts in the position in which they are usually found. He attributed the origin of most true mesenteric cysts to this developmental accident, but admitted that some might arise as diverticula from the intestine. This view has met with general favour and has been widely accepted, though some writers<sup>12</sup> regard the developmental error as primarily "an anomaly in the coalescence of the peritoneal mesenteries". Niosi<sup>7</sup> described a case in which he found nodules of suprarenal tissue in the walls of a mesenteric cyst, but this would be more illuminating if it were not, as it seems to be, a unique observation. The fact that the cyst is so often solitary appears to us to afford definite support to the view of their origin held by Dowd.

3. DIVERTICULA.—

a. *Intestinal*.—There is, however, good evidence that some of these cysts arise as diverticula from the intestine: these are enterogenous cysts, and constitute the group of 'cysts of intestinal origin' in Niosi's classification (p. 98) and the 'enterocystomata' in that of Carter (p. 98). This is a serious



rival to the 'embryonic' view, and requires further notice. It has been shown that intestinal diverticula occur regularly in the embryo of the pig, rabbit, and man. In one human embryo of 23 mm., Lewis and Thyng<sup>16</sup> found 33 'pockets', and in an older specimen 48. These were all diverticula of the small intestine, and in no human embryo did these authors find them along the border of the large intestine or vermiform process. Again, Wallmann<sup>17</sup> found 37 diverticula in a piece of small intestine 48 cm. long, and 30 of these were between the layers of the mesentery; but he also found some present in the large intestine. The duodenum is perhaps the commonest situation, and it is said that diverticula here occur frequently.<sup>18</sup> Since intestinal diverticula do occur in the human embryo, it requires no great imagination to suppose that, lying between the layers of the mesentery, they might become separated from their origin and form true mesenteric cysts.

Miller's case<sup>11</sup> seems to prove that this does occur: a female infant of four days died from a volvulus caused by a mesenteric cyst whose lumen did not communicate with the gut, but whose wall was directly continuous and identical in composition with the small intestine, from which it had undoubtedly arisen as a diverticulum. Other good examples of enterogenous cysts are given by Hunter<sup>19</sup> and Van der Bogert.<sup>2</sup> It may be difficult in some cases, where a few scattered plain muscle fibres are present in a wall of a cyst, to decide whether or not it is enterogenous; but when a regular arrangement of muscle fibres at right angles to one another can be demonstrated, and when the structure of the alimentary canal is exactly reproduced, even to the presence of villi on the inner wall of the cyst, there is a very strong presumption that it arose in this way.

*b. Meckel.*—Cysts might arise enterogenously in a second way, from a persistent Meckel's diverticulum, or from a persistent portion of the vitelline duct. This is a structure whose position varies, for it may "originate from any part of the gut and apparently from any aspect" (Miller, loc. cit.); but its average situation is stated to be 43 inches proximal to the ileocaecal valve. Although Meckel's diverticulum is present in only 2 per cent of individuals, there is no authority for thinking that microscopic remnants of the duct are as rare. In order that this explanation may be applied to cysts between the layers of the mesentery, it is necessary that the duct should have arisen on the concave side of the intestine.

Thus, if the enterogenous cysts be considered to arise both as intestinal diverticula and as growths from vitelline duct remnants, a situation "in the upper bowel would favour the former, and in the lower bowel the latter" (Miller, loc. cit.). This statement can only be applied to cysts arising in the true mesentery, but it is exceptional to find them elsewhere. In a recent paper in the BRITISH JOURNAL OF SURGERY, MacAuley<sup>20</sup> described a case of congenital ileocaecal cyst, and gave particulars of ten others dating from 1886 which he regarded as forming a definite group. In his example the cysts were almost all near the ileocaecal angle, and probably most of them arose from the ileum. It seems possible that these are enterogenous cysts which have pushed their way into the lumen of the gut. Their walls seem similar to those of the enterogenous cysts cited above, and Ayer's case,<sup>6</sup> which MacAuley gives as one of his series, was anatomically outside the caecum.

MacAuley, however, distinguishes them from other mesenteric cysts, though he does not consider their pathology. Professor Sir Arthur Keith, who reported on the specimen, regards it as an enterogenous cyst, but does not discuss its relation to mesenteric cysts.

**Summary.—**

1. True mesenteric cysts are not malignant, parasitic, or dermoid, but form a separate group in which are included the majority of all 'mesenteric cysts'.

2. Their origin is still in doubt, but it seems probable that there are two classes :—

*a.* Cysts of embryonic origin arising from mesodermal remnants incarcerated behind the developing peritoneum and subsequently migrating forward between its layers.

*b.* Cysts of intestinal origin : (i) Arising in most cases as diverticula from the bowel during development ; (ii) Possibly derived sometimes from persistent portions of the vitelline duct.

3. Some anomalous and hitherto unclassified cysts, such as the 'pararenal' example described as *Case 2*, are true mesenteric cysts which have developed from mesodermal remnants behind the peritoneum, but which, unlike the ordinary clinical mesenteric cyst, have not moved anteriorly into the developing peritoneal folds.

It is important to distinguish the cysts of which we speak from the large cysts of the kidney which occur generally singly and quite apart from chronic nephritis, congenital cystic disease, and echinococcus infection ; these are cysts of the kidney substance proper, and may communicate with the pelvis or contain fluid closely allied to urine, whereas the pararenal variety is definitely outside the kidney, and, though they may indent its substance, are not attached to it, and contain the characteristic fluid previously described. Pararenal (or paranephric) cysts are very rare, and have received scant notice in the text-books. There is no mention of them in *Keen's Surgery*, and only a few lines in some of the standard works on urology. Thus, Morris, Garceau, Thomson-Walker, and Kidd all refer briefly to them, and allude to a possible origin from Wolffian body remnants ; but no attempt seems to have been made to associate them particularly with mesenteric cysts, nor does their close resemblance, and that of their contents, to mesenteric cysts seem to have received due notice.

**SYMPTOMATOLOGY AND DIAGNOSIS.**

The clinical aspects of these cases are of considerable surgical interest, and accord with the size, situation, and character of the cyst. Quite often the picture is that of a symptomatically silent abdominal tumour, though if this is of large size there may be associated discomfort. On the other hand, signs of subacute intestinal obstruction may be present, viz., attacks of distention associated with colicky abdominal pain and vomiting. In either case acute symptoms may supervene at any time, and then indicate the onset of obstruction due to any of the complications. The classical clinical sign is the *tumour* ; this corresponds in position to the anatomical site of the

mesentery, and is, generally, more or less central in position. It is smooth, rounded, and cystic, though this last point may not be easily determined in the case of a tense cyst felt through the abdominal wall. In the typical example the mobility of the tumour is the striking feature, and this is usually greater in the transverse than in the vertical direction, in accordance with its mesenteric attachment. General wasting is not a characteristic of the condition, even when a large tumour is present and obstruction of the lacteals might be expected.

The differential diagnosis may be considered briefly under two heads: (1) Diagnosis from other intra-abdominal tumours; (2) Diagnosis between individuals cysts.

In a typical case the situation, mobility, and general characters of the tumour may localize it with probability to the mesentery, and serve to distinguish it from other abdominal swellings, e.g., ovarian or kidney tumours. Its cystic character may also be clear, but even then the exact nature of the tumour can only be surmised. It should usually be possible to exclude parasitic and malignant cysts; but a tuberculous abscess in the mesentery may present all the features enumerated above, and indeed, in childhood at any rate, is the most common type of 'mesenteric cyst' to be exposed by operation!

An Italian writer<sup>21</sup> has made the following pathetic pronouncement on the subject of the diagnosis of mesenteric cysts: we give Braquehay's French translation: "*Sans se torturer autant et inutilement l'esprit, la seule chose à faire est une laparotomie exploratrice*".

Though it is admittedly a very difficult diagnosis to make, yet there are cases where, once suspected, a mesenteric cyst should be diagnosed. Obviously the attempt ought always to be made.

### COMPLICATIONS.

Because of their surgical importance it is necessary to enumerate the complications to which these cysts are liable. Often enough it has been at operation on a puzzling 'acute abdomen' that the existence of an unsuspected mesenteric cyst has been revealed.

1. Intestinal obstruction is the most frequent and the most serious of the common complications. In a small series<sup>11</sup> of 17 enterogenous cysts, acute obstruction occurred in nearly 50 per cent, whilst the group mortality of 35 cases of obstruction due to this cause was 35 per cent. The methods by which it may be brought about are mechanical, and include volvulus, intussusception, kinking, adhesions, and a narrowing or occlusion of the gut by pressure of the tumour or stretching of the intestine over it.

2. Peritonitis, when it occurs, is a sequel to the above.

3. Hæmorrhage into the cyst has caused death.<sup>14</sup>

4. Rupture of the cyst may also cause death (Timbal, loc. cit.); but there are two cases of recovery<sup>22, 23</sup> following what seems to have been spontaneous rupture of the cyst into the bowel.

5. Torsion of the cyst.

6. If a mesenteric cyst occupies the pelvis, it may itself become impacted, or may give rise to symptoms varying with the organ upon which it presses.

### TREATMENT.

It has been stated above that spontaneous recovery has followed rupture of a mesenteric cyst; nevertheless it is clear that surgical treatment is called for in every case, even though an exact diagnosis may not have been made before operation. The treatment required is governed by the urgency of the case, thus:—

1. **The Acute.**—This comprises the abdominal emergencies which may be due to any of the complications already enumerated; treatment in such cases follows the ordinary lines without necessarily permitting an attack on the causal cyst.

2. **The Subacute or Chronic.**—In this group are the ordinary uncomplicated cases; these require an operation for the removal of the cyst, or, if this is impossible, some procedure which will relieve symptoms and give hope of cure. The following methods have been used:—

*a. Aspiration.*—This is no longer practised except as a stage in more radical operations.

*b. Enucleation of the Cyst.*—This is the ideal treatment, but is not always possible.

*c. Resection of the Involved Segment of Intestine.*—Partial resection is sometimes necessary to extirpate a cyst, but it is a severe undertaking, and in these cases carries a mortality of 60 per cent.<sup>11</sup>

*d. Drainage by Marsupialization.*—The cyst wall is sutured to the abdominal parietes, and some operators, hoping to induce adhesions and obliteration of the cavity, apply caustics to the wall of the cyst.

Certain objections have been raised against enucleation and marsupialization: these may be set out as follows:—

*Objections to Enucleation.*—(a) That it is a more difficult and dangerous operation than marsupialization; (b) That it is sometimes impossible to accomplish because of extensive adhesions, the large size of the cyst, or its intra-intestinal position; (c) That it is liable to damage the intestinal vessels and nerves; (d) That it may injure the solar plexus. We have been unable to find statistics on the operative mortality sufficiently recent to be of value. Braquehay, in 1892, gave that of enucleation as 40 per cent. and of drainage as 6 or 7 per cent; but Miller (*loc. cit.*), in 1913, records ten enucleations without a death, and simple drainage must nowadays have a very low mortality.

*Objections to Drainage by Marsupialization.*—(a) That the cyst wall is not removed and that there is consequently no guarantee of cure; (b) That convalescence is long and a persistent sinus may result; (c) That post-operative complications are liable to follow, notably intestinal obstruction. The first and third would be serious disadvantages if they occurred at all frequently; but cure is almost invariable, and post-operative complications are extremely rare.

**Summary.**—

*a.* Either simple enucleation of the cyst or marsupialization of its wall, and drainage of the cavity, should be practised in every uncomplicated case.

*b.* Enucleation is the operation of choice, but only when it can be done without resort to intestinal resection.

*c.* Marsupialization and drainage should be performed in the remaining cases. It is an old operation—Péan in 1880 is said<sup>15</sup> to have been the first to establish it as the appropriate surgical treatment for mesenteric cysts—but it is easy, safe, and universally applicable.

Care should be taken not to overlook undrained loculi or secondary cysts, and strong caustics should not be used.

**CONCLUSIONS.**

1. True mesenteric cysts are to be distinguished from other cysts found in the mesentery; their occurrence in this situation is not a topographical accident (cf. hydatid and malignant disease), but bears an important relation to their etiology and pathology.

2. To this group belong the greater number of mesenteric cysts.

3. Their origin is still in doubt, but the evidence that some true mesenteric cysts are enterogenous and arise primarily as diverticula of the alimentary tract is very strong and must be accepted.

4. The view which attributes the origin of enterogenous cysts to persistent remains of the vitelline duct is a possibility, although one restricted by the anatomical position of the duct. It cannot at present be considered proved.

5. The embryonic (Wolffian body remnants) explanation is attractive and applicable to a mesenteric cyst irrespective of its position. This view rests only upon strong probability, and is, by its very nature, difficult of proof; nevertheless it appears to us to afford the most plausible explanation of the origin in the majority of cases.

6. These cysts are diagnosed with difficulty, but they are amenable to surgery, although they are liable to cause complications which greatly increase the danger to life.

7. The first of the two patients whom we have described was found to have a typical though large mesenteric cyst. In the second the cyst was near the upper pole of the right kidney, though it was clearly not attached either to the kidney or to the suprarenal body; its macroscopic and microscopic characters were identical with those of a mesenteric cyst. We suggest that this also was an example of so-called mesenteric cyst, and that it arose from remains of the Wolffian body, and hence came to occupy a situation in close relation to the kidney. If it is admitted that this cyst, which bears such a close resemblance to the mesenteric cysts, arose in this way, then it seems to lend additional support to Dowd's explanation of the origin of mesenteric cysts.

8. Whether or not this is so, the term mesenteric cyst is a bad one, even when applied to the true cysts which we have discussed. Cunéo<sup>12</sup> in 1909 suggested 'paraperitoneal' as an improvement in nomenclature, and, if further

investigation should reveal a common pathology for some of the ill-defined varieties of retroperitoneal cysts, it may be that this word will be usefully employed in a wider sense than its author intended.

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## ON THE ATTEMPTED PRODUCTION OF AN 'ASCENDING' RENAL INFECTION IN RABBITS.\*

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It was shown by one of us (D.) in a previous communication<sup>1</sup> that, using the *Staphylococcus aureus*, it was an easy matter to bring about an infection of the kidney in the rabbit by way of the blood-stream. The present series of experiments was undertaken with the view of ascertaining if it were possible to bring about an 'ascending' infection of the kidney, using the term in the sense of an infection passing with the urine by a reversal of the usual direction of flow from the bladder into the ureter and thence into the renal tubules. The *Staphylococcus aureus* having, for reasons stated in the report, been used in the previous investigation, was also made use of in the present instance.

The problem naturally divides itself so as to fall under two heads: (I) The possibility of infection of the ureter from the bladder; and (II) The ureteric infection being established, whether it can pass by way of the lumina of the tubules into the kidney.

Various workers have obtained results indicating that fluid may pass from the bladder into the ureter with comparative ease. Thus Lewin and Goldschmidt<sup>2</sup> using milk, and Courtade and Albarran<sup>3</sup> using Indian ink, reported that regurgitation took place from the bladder into the ureter in rabbits; and Kretschmer<sup>4</sup> reported filling of the ureter from the bladder, demonstrable by X rays in four out of eleven children investigated. These results seemed to indicate that infection of the ureter from the bladder should be an easy matter. Such, however, was not found to be the case.

### I. ATTEMPTED INFECTION OF THE URETER FROM THE BLADDER.

The first step was to produce a cystitis; this proved more difficult than was anticipated. The simple injection of organisms into the bladder was first tried.

EXPERIMENT 1.—One c.c. of a thick emulsion of *Staphylococcus aureus* in broth was injected by means of a glass catheter into the bladder of a male rabbit. Specimen of urine obtained by catheterization twenty-four hours later showed no pus-cells, but gave a free growth of the organism on culture. Seventy-two hours later a further specimen showed a diminished number of colonics on culture; one week later organisms were absent from the urine.

The experiment was repeated on several occasions and, although the length of time during which the organisms remained present in the urine

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differed in individual cases, the results were all substantially the same. The organisms disappeared from the urine in a few days, and none of the animals treated in this way showed any signs of illness.

Simple introduction of organisms into the bladder having proved a failure, so far as infection of that viscus, much more so of the ureter, was concerned, the question of applying trauma to the bladder with the hope of rendering it more susceptible to infection was next considered. The introduction of turpentine has been shown by various workers to be a highly successful agent for this purpose. The effects of this irritant are well described by David,<sup>5</sup> and it is obvious from his account that the damage to the mucous membrane produced by it is such as to render infection of the blood-stream from the lumen of the bladder an easy matter. Since it was particularly desired to avoid any possibility of infection by this route, this agent was not employed. An attempt was made to provide a reservoir of organisms in the bladder, so that the viscus would be submitted to a continuous inoculation, the organisms in the reservoir being out of reach of the protective mechanism of the bladder wall. To this end a piece of porous earthenware soaked in an emulsion of living staphylococci was inserted into the bladder; but this was found to produce excoriation of the mucous membrane, which again introduced the possibility of spread of infection by the blood-stream. Choice was finally made of a piece of soft Turkey sponge. The following is typical of several experiments:—

EXPERIMENT 2.—Under ether anaesthesia the bladder was exposed by a suprapubic incision and opened transperitoneally through its anterior superior surface. The urine was swabbed out, and a piece of Turkey sponge about the size of a pea when compressed, but capable of expanding to about 2 cm. in diameter, was introduced. Ten drops of a thick emulsion of staphylococci in broth were allowed to fall upon the sponge, by which they were at once absorbed without having come in contact with the edges of the wound in the bladder wall. The bladder was then sutured with a seromuscular stitch, the suture line being covered by a small peritoneal fold containing fat, and the suprapubic wound closed.

Forty-eight hours later the rabbit appeared in fair health. Urine withdrawn by catheterization contained pus-cells and gave staphylococci on culture. On the fifth day from operation the animal was killed. On opening the bladder, which was contracted and contained very little urine, the sponge was not found, having apparently been voided: the mucous membrane was very swollen and oedematous; the ureters, kidneys, and all other organs showed nothing unusual, either to the naked eye or microscopically. Pus-cells were present in such urine as could be obtained from the bladder, and it gave a free growth of staphylococci.

It might have been anticipated that the above method of incising the bladder wall transperitoneally and then inserting a living culture of organisms would almost certainly give rise to peritonitis, or infection of the bladder wound, or both, with a consequent blood infection. It was hoped, however, that the organisms would remain in the sponge for an hour or so, and would not be diffused by urine all over the bladder, until the wound had had time to become sealed by clot. The success of this method was shown in practice in that, although the experiment was performed some six times for one reason or another, in no instance did the peritoneum become infected, and in only one did an abscess form in the bladder wound; this last case is described more fully later (*Experiment 6*).



The above experiment was repeated twice, and always with substantially the same results. In every instance an inflammation of the mucous membrane was produced, though in no instance was the sponge found in the bladder post mortem. Apparently the presence of the foreign body containing organisms in its mesh, even for the short time that it was in the bladder, was capable of rendering the mucous membrane susceptible to infection by the coccus. In every instance sections of the ureters and kidneys were cut and examined microscopically, but beyond some cloudy swelling in the tubular epithelium of the latter, no evidence of infection could be detected.

With a view to demonstrating the organism, if present at all in the kidneys, these were, in one case, removed immediately after death and incubated overnight in a sterile Petri dish; sections were then cut and examined for organisms. In the previous investigation one of us (D.) had found this to be a particularly successful method of demonstrating living cocci when present in the kidney, but in this case there was a negative result.

As it might be objected that sufficient time had not elapsed for infection to pass from the bladder to the kidneys, a vesical infection was produced in two rabbits (*Experiment 3*) in the manner described above, and the animals were allowed to survive. Pus-cells and organisms had disappeared from their urine by the *tenth day*, and, at post-mortem at the end of a month, the kidneys of both were perfectly normal.

The above experiments showed that, whatever may be the case as to passage of urine from the bladder back into the ureters, the production of infection in this way does not occur readily, if at all. David thought that he secured evidence of infection in this way; but, as pointed out above, he used turpentine to render the bladder susceptible to infection, thereby opening the road for blood-borne infection to take place. It is noteworthy that Draper and Braasch<sup>6</sup> could find no evidence of regurgitation from the bladder into the ureter, even when considerable pressure was used, and after slitting up the mouth of the ureteric opening in the bladder wall. They attached even more importance to the sphincteric activity of the lower end of the ureter than to the valvelike arrangement of the opening of the ureter into the bladder.

**Carmine Injection into Bladder.**—In one experiment a tentative effort was made to effect the passage of an easily recognizable inert substance from the bladder into the ureter, as follows:—

**EXPERIMENT 4.**—Under ether anæsthesia the bladder of a large rabbit was exposed; it was found dilated with urine; 1 c.c. of a thick emulsion of carmine was introduced by means of a catheter, and the urethra ligated. The abdominal incision was temporarily closed, and the animal kept under light ether anæsthesia for four hours. At the end of that time the bladder was again exposed, and found to have become considerably more distended with urine. The ureters showed no signs of dilatation. The rabbit was killed and, in order to prevent any relaxation of the vesico-ureteric opening after death, plunged at once into Kaiserling's solution. When thoroughly fixed, the bladder and ureters were opened. No trace of carmine staining was present in either ureter, indicating that, in spite of the tension in the bladder caused by obstruction of the urethra, no regurgitation of the urine had occurred.

Such a single experiment cannot be conclusive, but it agrees with the findings of Draper and Braasch.

**Effect of Trauma on Susceptibility of Kidney to Infection of Bladder.**  
—Attention was now directed to the effect of trauma in rendering the kidney susceptible to infection from an infected bladder.

A subtle form of trauma seemed to be offered by temporary or permanent occlusion of the ureter. Lepper,<sup>7</sup> using *B. coli*, found that, although organisms injected into the blood-stream in the dosage used by her did not, under ordinary circumstances, make their appearance in the urine, they did so if the ureter of one kidney were temporarily occluded; this she believed to be due to trauma caused to the kidney by even temporary closing of the ureter. Some evidence as to the nature of this trauma is given later. The following experiment was performed:—

**EXPERIMENT 5.**—Under ether anaesthesia the ureter was exposed through a median abdominal incision, and a bulldog clip applied at about its middle. The wound was then partially closed, but in such a manner as to leave the handle of the clip protruding, and 1 c.c. of an emulsion of staphylococcus was introduced by catheter into the bladder. The wound with the clip protruding was covered by a sterile dressing, and the animal left for one hour. At the end of that time the clip was removed and the wound finally closed. Forty hours later urine removed by catheterization showed no pus-cells and gave only a few colonies of staphylococci on culture. Thereafter specimens of urine showed nothing abnormal.

This experiment was repeated once. On killing the second rabbit, some scarring and consequent contraction of the ureter at the site of application of the clip, but insufficient to cause complete occlusion, was found; the ureter above this point, and the pelvis, were both somewhat dilated, but there was no sign of infection of the kidney.

On the assumption, which as subsequent experiments showed was not justified, that any trauma to the kidney produced by obstruction of the ureter would be progressive, it was now determined to infect the bladder, to give the infection ample time to reach the lumen of the ureter, and then to ligate that structure. It was hoped that the disturbance produced by the obstruction of the ureter would be effectual in bringing about a renal infection.

**EXPERIMENT 6.**—In the manner described above, a cystitis was brought about by the introduction of infected Turkey sponge. Five days later, under ether anaesthesia, and through a median incision, the left ureter was ligated in two places and a portion removed from its middle. The wound was then closed. Eight days later the animal, which for some days past had shown signs of illness, was killed. At autopsy the left kidney was found to be greatly enlarged and to show collections of pus beneath the capsule; the pelvis and ureter were both enormously dilated. On section, the dilated pelvis was found to be filled with pus, and areas of suppuration were apparent tracking through the kidney substance from pelvis to capsule, under which were several abscesses of all sizes. Three septic infarcts were to be seen in the substance of the kidney (*Fig. 80*).

Cultures of pus from the left pelvis gave a free growth of *Staphylococcus aureus*; cultures from the heart blood and right renal pelvis were sterile. From the bladder urine, staphylococci were grown.

On opening the bladder, an abscess was found surrounding the sutures in the wall of the organ.

In this experiment a severe infection of the kidney had been brought about; as to the mode of this infection, there were two possible explanations. In the first place, it might be assumed that the cocci had made their way from the bladder into the ureter before it was ligated, and that after occlusion of that structure they had produced the infection of the kidney, weakened as a result of the operation. This explanation is hardly probable, inasmuch

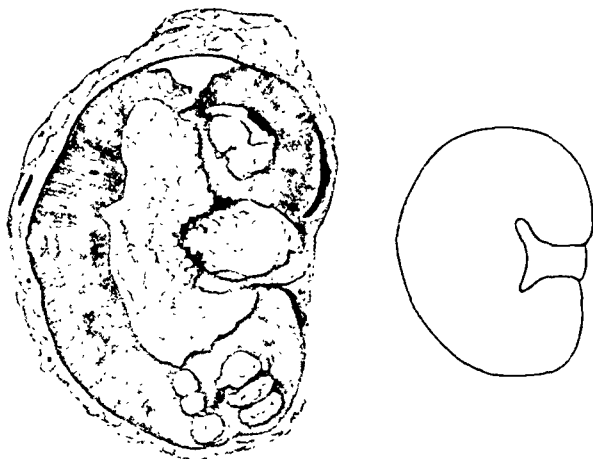


FIG. 80.—Abscess formation in *Experiment 6*. Outline figure shows size of unaffected kidney.

as the segment of ureter removed five days after the bladder was infected was quite normal on microscopical examination, indicating that no infection was present in the ureter at the time that structure was ligated. In the second place, the renal infection might be explained as having been borne from the abscess in the bladder wall by the blood-stream. The presence of septic infarcts in the kidney offered support to this second view.

This experiment was repeated, and in three other

experiments (7, 8, and 9) the infection of the bladder was brought about at the same time, two days and one week respectively prior to the occlusion of one ureter. *Experiments 8 and 9* were each performed twice. In none of these further experiments was an infection of the kidney procured, and in none of them was any infection of the operative wound in the bladder present, such as was described under *Experiment 6*.

**Early Changes in Kidney following on Occlusion of Ureter.**—At this point it seemed desirable to obtain some first-hand information as to the more immediate effects of occlusion of the ureter upon the kidney. In *Experiments 10 to 15*, the ureter was exposed under ether anaesthesia through a median incision and a ligature applied at the junction of the lower and middle thirds. This procedure was carried out without in any way touching either the kidney itself or its vessels. The importance of this is indicated hereafter. The abdominal wound was then closed, and the animals were allowed to survive for one hour, two, three, and five days, and one and two weeks respectively. In every instance the animal was killed at the end of the time stated, the kidney removed at once and put into Kaiserling's solution, and only sectioned after it had become hard.

**EXPERIMENT 10.**—Animal killed one hour from time of obstruction of the ureter. On cutting open the kidney after fixation, the pelvis and ureter were found greatly dilated. The renal papilla was flattened out and the medulla compressed, but the cortex showed no diminution in thickness. On microscopical examination the most striking change was the presence of numerous areas of hæmorrhage; these

were most plentiful in the cortex and boundary zone, and appeared to be due to the rupture, following upon overfilling, of the intertubular capillaries; the presence of great engorgement of the veins in conjunction with comparative emptiness of the arteries suggested obstruction of the venous outflow as the cause of these hæmorrhages. So far as could be ascertained, this obstruction was due to pressure exerted by the tense walls of the greatly dilated pelvis upon the arcuate system of veins in the kidney. The tubules of cortex and medulla alike were greatly dilated, obviously as the result of the pressure of the secreted urine within them.

EXPERIMENT 11.—Animal killed twenty-four hours from time of ligation of the ureter. Macroscopically the appearances were very similar to those in *Experiment 10*. The walls of the pelvis were greatly swollen and dark red in colour, and the urine retained in the pelvis was dark brown and contained many red blood-cells. Microscopic examination showed no increase in the areas of hæmorrhage described under *Experiment 10*, but in other respects they revealed a further advance of the state of affairs seen after one hour's ligation: the dilatation of the tubules, more particularly those of the cortex, was greatly increased; the medulla showed further signs of the influence of the pressure exerted by the contents of the dilated pelvis, the tubules in this area, as they approached the papilla, showing a sharp bend due to the stretching of the medulla and flattening of the papilla; this bend had apparently resulted in the occlusion of the tubules, thus, to a large extent at any rate, cutting off the lumina of the cortical tubules from any direct connection with the cavity of the pelvis.

EXPERIMENTS 12, 13, 14, 15.—Ureter obstructed for three, five, and seven days, and two weeks. Macroscopically these all showed the same features as described under *Experiments 10* and *11*. The pelvis showed little increase in size in any of these experiments on that attained after twenty-four hours' obstruction; the substance of the kidney itself, however, showed a slowly progressive dilatation, accompanied by great stretching and flattening of the medulla, though even after two weeks' obstruction a deep strip of cortex remained, spread out over the dilated renal sinus. After the third day the venous congestion became progressively less and less, while the areas of hæmorrhage had completely disappeared at the end of a week—apparently as the result of absorption. By the end of two weeks the dilatation of some of the tubules of the cortex had become extreme; others were compressed and had their lumina occluded; the compressed tubules tended to occur in well-defined areas, mapping out the areas in which dilatation of the tubules had occurred, the result of this arrangement being to give a honeycomb appearance to sections of the cortex as viewed through a hand lens. This progressive dilatation of the tubules speaks for a continued secretory activity on the part of the kidney. The urine thus secreted being to a large extent retained in the tubules as the result of the flattening of the medullary tubules and their angulation, as pointed out under *Experiment 10*. The cells of the dilated cortical tubules were flattened, but otherwise appeared healthy; the epithelium of the compressed tubules also stained well, but in some of the tubules the basement membrane had disappeared, presumably indicating the first step towards the dissolution of these tubules. The glomeruli showed no dilatation.

The above experiments show that the most striking of the more immediate effects of obstruction of the ureter on the kidney is not, as might be expected, the onset of a progressive degeneration of the secreting tissue, but, on the contrary, an almost immediate, sudden trauma in the shape of interstitial focal hæmorrhages, with a strong tendency to recovery. In order to be sure that these hæmorrhages are due directly to ligation of the ureter, it is, of course, essential to ligate that vessel as is described above, without handling the kidney. Any such method as delivering the kidney through a loin incision preparatory to ligating its ureter produces extensive hæmorrhages and masks

the effect of the ureteric ligature. This production of traumatic hæmorrhages must be borne in mind in all experiments upon the kidney involving ligature of the ureter, and, taking it into consideration, the most probable explanation of the infection of the kidney in *Experiment 6* would seem to be that it was carried by way of the blood-stream from the abscess in the bladder to one of the hæmorrhagic areas in the renal substance.

## II. INFECTION OF THE KIDNEY FROM THE URETER.

Attempts at producing an 'ascending' infection of the urinary tract from the bladder having given only the above negative or equivocal results, attention was now directed to the possibility of the passage of infection from the ureter into the kidney.

EXPERIMENT 16.—Under ether anæsthesia the ureter was exposed through an abdominal incision and ligated at the junction of the lower and middle thirds. A glass cannula was inserted into the proximal end of the ureter, and the ureter divided below the point of insertion of the cannula. The proximal end and cannula were brought out through the abdominal wound, which was then sutured and sealed with collodion; 1 c.c. of an emulsion of staphylococcus was introduced through the cannula into the ureter, the ureter ligated just above the cannula, and the latter removed. The introduction of organisms into the ureter was carried out in this way to avoid contamination of the peritoneal cavity, which in no instance occurred. Forty-eight hours later the animal was killed. The kidney was found greatly swollen, with numerous and extensive subcapsular abscesses about the lower pole; in fact the condition closely resembled that of 'surgical kidney', with the difference that owing to the ligature of the ureter the pelvis was greatly dilated with pus.

The problem now was to determine whether the infection had 'ascended' in the strict sense of the term by way of the lumina of the tubules into the renal substance, or whether infection of the kidney had been the result of direct spread into the interstitial tissue; the appearances of abscesses under the capsule, while the main mass of pus was confined to the pelvis, suggested that a real 'ascent' of the infection might have occurred. Microscopic sections, however, did not confirm this view; these showed the medulla stretched out and compressed by the mass of pus and urine in the pelvis; the epithelium of the tubules in immediate relationship to this pus was necrotic, apparently as the result of spread of toxin into the tissues, the necrosis grading off into degeneration, and then into cloudy swelling, as the neighbourhood of the pus was left. In places the infecting cocci, by reason of the dissolution of the epithelial lining of the renal sinus, had gained access for a very short distance into the interstitial tissue of the medulla; but nowhere could pus-cells or cocci be demonstrated in the lumina of the tubules.

The abscesses under the capsule at the lower pole were found to be due to the direct spread of the infection from the pelvis through a rupture in the epithelium of the sinus, where it was reflected from the pelvis on to the papilla, and thence up under the capsule, without affection of the underlying cortex. It was conjectured that this rupture had been brought about by the use of too great an amount of emulsion for the injection, and of too great force in

its performance. This was confirmed in a further experiment (*Experiment 17*), in which only 0.2 c.c. of the staphylococcal emulsion was used; in this case, although the same infection of the pelvis was produced, the subcapsular abscesses were absent.

**Carminic Injection into Ureter.**—Since experiments with living cocci necessitated the early destruction of the animal, and moreover produced progressive changes of a rather uncontrollable nature, they were repeated using a suspension of carmine; the use of this material made it possible to leave the animal for as long as wished after its introduction, in order to give ample time for it to find its way from the pelvis into the kidney, were it capable of so doing.

In the first of these experiments, Nos. 18 and 19, 1 c.c. of the carmine, used in a heavy emulsion in distilled water, was introduced into the left ureter, which was thereafter ligated, in the manner described above; the animals were killed twenty-four and forty-eight hours respectively from the time of the injection. In both cases the appearances after death were very similar; but, since they were more striking in the rabbit which had been allowed to survive for forty-eight hours, this alone will be described. At post-mortem,



FIG. 81.—Mode of spread of carmine from pelvis out under the capsule in Experiments 18 and 19.

the pelvis and ureter as far as the ligature were found greatly dilated and filled with carmine; at the lower pole of the kidney was a deeply stained area caused by the appearance of the carmine beneath the capsule (*Fig. 81*). On laying the kidney open after fixation, it was apparent that this subcapsular staining had been produced by the direct passage of the carmine from the pelvis, out beneath the true renal capsule, without its having entered into the substance of the kidney at all. Macroscopically the kidney showed the usual flattening of the medulla, but no evidence of carmine within its substance.

On microscopic examination it was at once evident that, as in the first experiments in which living cocci were used, the amount of the injected material had been too great and that rupture of the epithelium lining the renal sinus had been effected (*Fig. 82*). It was through such a rupture that the carmine had passed out from the pelvis beneath the capsule covering the lower pole of the kidney. Microscopic examination of the sections showed rupture of the epithelium, not only at the junction of the pelvic wall and capsule, but also over the surface of the kidney bounding the renal sinus. At some of these points of rupture of the epithelium hæmorrhage had occurred, and in one of them a mixture of red corpuscles and carmine granules was to be

seen actually lying within the interstitial substance of the kidney (*Fig. 83*). Further examination of this kidney revealed granules of carmine lying within vessels, sometimes free, sometimes contained within the lining endothelium, and in many cases at some considerable distance from the site of the hæmorrhage; it was not possible in every instance to be sure if the vessels concerned were lymphatics or capillaries; some were undoubtedly blood-vessels, and the probability is that both were implicated. Furthermore, a number of the convoluted tubules in the immediate neighbourhood of the carmine-

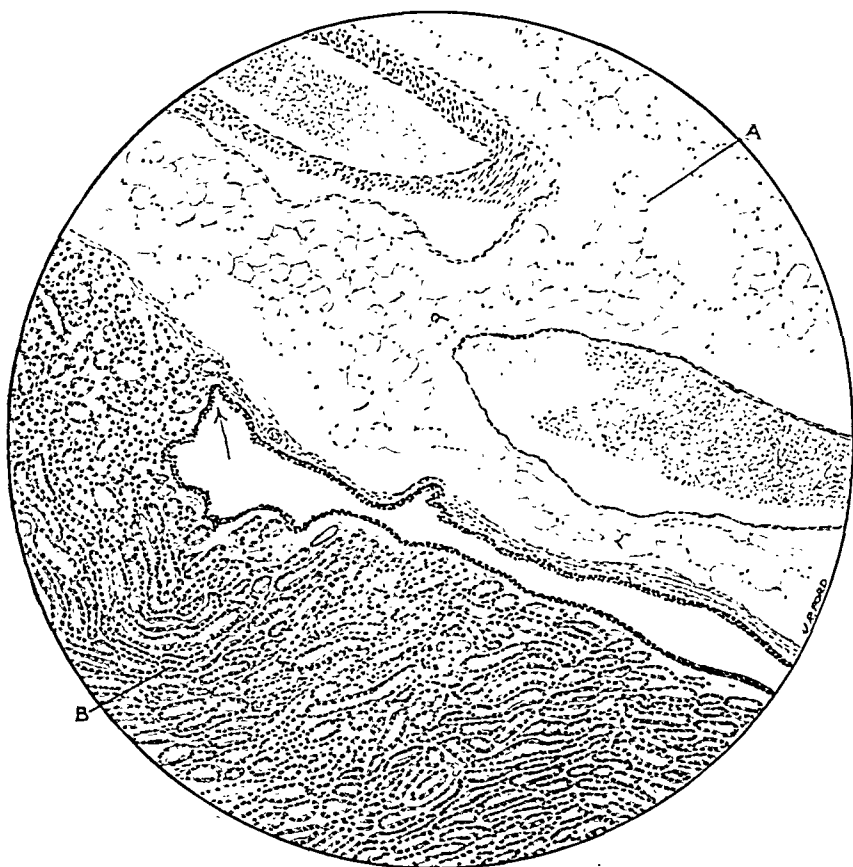


FIG. 82.—Reflection of epithelium of renal sinus from papilla (B) on to pelvic wall (A); the arrow shows site of rupture in *Experiments 18 and 19*.

containing hæmorrhagic areas showed numerous minute granules of carmine within their lining epithelial cells (*Fig. 84*). In no instance was a granule of carmine detected within the lumen of a tubule, though some of the tubules contained a pinkish homogeneous substance (*Fig. 84, A*) which may have been albumin stained by carmine secreted in solution in the alkaline urine and coagulated by the fixative. These appearances might seem to indicate that the carmine had been taken up by the blood or lymph or both from the carmine-containing hæmorrhagic area, and was in course of being excreted

by the tubular epithelium; a more probable explanation is that the appearances were due to vital staining of the bioplastic granules of the epithelial cells by the carmine.

Whatever may have been the manner in which the carmine granules reached the epithelium of some of the convoluted tubules, it was quite evident that none of it had reached the interior of the kidney by passage from the pelvis up the lumina of the tubules.



FIG. 83.—Bursting of carmine through epithelium of renal sinus and into interstitial tissue of kidney in *Experiments 18 and 19*. Haematoxylin stain.

A further experiment, No. 20, in which only 0.3 c.c. of the emulsion was used and the animal was left for five days in order to give the carmine every opportunity of passing from the pelvis into the kidney, confirmed this view. In this animal no rupture of the epithelium of the renal sinus was found post mortem, and, although the pelvis was full of the emulsion, no trace of it could be detected in the kidney, either macro- or microscopically.

Burns and Swartz,<sup>6</sup> using dogs, report that they found no difficulty in bringing about the passage of Indian ink from the ureter into the kidney.



They state that in animals killed half an hour from the time of the injection under a hydrostatic pressure of six inches of a small amount of this substance into the ureter, they were able to demonstrate the ink "in the collecting tubules, the distal convoluted tubules, the ascending and descending limbs of Henle's loop, the proximal convoluted tubules, the capsule of Bowman, in the spaces between the tufts of the capillaries of the glomeruli, and in the capillaries themselves".



FIG. 84.—High-power drawing of portion of Fig. 83 within circle, showing carmine-stained granules in epithelial cells. A, The pink substance referred to on p. 114.

The difference between these findings and those given above in connection with carmine injections is so striking that it was considered necessary to repeat the experiment, using Indian ink, with a view to ascertaining if there is any radical difference in the behaviour of the two substances.

In *Experiments* 21 and 22 Indian ink was allowed to flow by gravity from a height, in the one case of 6 inches, in the other of 9 inches, into the ureter, which had been cannularized. The pressure was kept up for half an hour, the animal being all the time under light ether anæsthesia. At the end of

this time the ureter was ligated, the animal killed, and the kidney removed and fixed. In both cases the findings were identical. The pelvis was filled with the ink, but the most careful microscopical examination failed to show the entrance of a particle of the injected material into the tubular system of the kidney.

### DISCUSSION.

The uniformly negative result of all the experiments described above, performed with the view of bringing about the passage of cocci or carmine granules, or Indian ink, from the pelvis into the renal tubules, points to the conclusion that the renal papilla stands guard over the tubular system of the kidney, acting as a valve, passage through which in the reverse direction is a matter of impossibility. If the results described above are correctly interpreted, it would seem that an 'ascending' infection of the kidney, in the sense of the passage of infection from the pelvis into the renal tubules, can never take place.

In *Experiments 16, 18, and 19*, however, the possibility of infection of the kidney from the pelvis in a manner other than the direct passage of infected urine in the reverse direction into the renal tubules was demonstrated. These experiments showed that by a sudden increase of the fluid pressure within the pelvis it was possible to effect a rupture of the epithelium of the renal sinus. Such a rupture occurring at the junction of the pelvic wall and renal capsule allowed the passage of the pelvic contents outwards underneath the capsule, and in the presence of an infecting agent might give rise to a condition indistinguishable from a clinical 'surgical kidney'. It is probable that an increase in the pressure within the pelvis, to a height sufficient thus to bring about a rupture of the epithelium lining the renal sinus, could only be caused by a mechanical injection such as was used in the experiments. It is possibly conceivable that such an effect might be produced by a sudden stoppage of the urinary passages such as may occur with a stone in a ureter; but even that is conjectural. There can, however, be little doubt that in therapeutic irrigation of the pelvis through a ureteric catheter it would, by the use of sufficient force, be easy to bring about such a rupture of the epithelium of the sinus. It seems quite possible that exacerbations of renal infection such as are sometimes seen following on pelvic irrigation may be due to this cause. The experimental results provide indications for caution in so far as the volume of irrigation fluid used and the degree of pressure under which it is injected are concerned.

### SUMMARY AND CONCLUSION.

A series of experiments is described, designed, if possible, to bring about an 'ascending' infection of the kidney, using the term 'ascending' in the sense of an infection passing into the kidney via the lumina of the urinary passages. Attempts directed to bring about infection of the ureter from the bladder showed that the uretero-vesical junction offered, under the experimental conditions, an insuperable bar to the passage of infection from the bladder upwards. By direct infection of the lumen of the ureter it was found

to be possible to bring about a subsequent infection of the kidney; but this infection was due, not to regurgitation of the infected pelvic contents into the renal tubules, but to direct spread through the epithelium of the renal sinus into the interstitial substance of the kidney, and under certain conditions, into the space between the kidney and its true capsule. Carmine injected into the pelvis did not pass through the renal papilla, which appeared to offer an impassable barrier to a reversal of the urinary flow.

No evidence could be obtained of the possibility of the occurrence of an 'ascending' renal infection.

The thanks of the authors are due to Sir Cuthbert Wallace, Director of the Surgical Unit, St. Thomas's Hospital, and to the Medical Research Council, without assistance from which the work could not have been carried out.

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## RETROPERITONEAL CYSTS : THEIR PATHOLOGY, DIAGNOSIS, AND TREATMENT.

By R. M. HANDFIELD-JONES, LONDON.

*(Being the Hunterian Lecture delivered at the Royal College of Surgeons of England on  
Wednesday, Jan. 23, 1924.)*

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- 

### I. INTRODUCTION.

It may perhaps be said with some justice that retroperitoneal cysts are of academic rather than practical interest; but I believe that they are of some importance, for several reasons. First, it will be generally agreed that the study of embryology is not sufficiently often referred to in dealing with the etiology of disease. We touch lightly, and not always very accurately, upon embryological facts for the explanation of such conditions as hare-lip, cleft palate, thyroglossal and branchial cysts; but there are undoubtedly many more complicated problems upon the etiology of which embryology may be expected to shed further light; and I am convinced that we are on the threshold of much important work based on the correlation of embryological and pathological methods. Many retroperitoneal cysts are developmental in origin, and I hope to show how a study of the processes involved sheds considerable light upon their origin. Secondly, these cysts are not common, and in the past but little work has been done upon them, and the literature on the subject is most confusing.

My attention was first directed to them by a case in St. Mary's Hospital, in 1920, and, as is the experience of us all, examples of rare diseases do not

come singly but in twos and threes. Three cases of retroperitoneal cysts were admitted within two months, and since then none have been seen, though I have personal knowledge of two others. The first case was impressed on my mind partly because of its intrinsic interest, partly because it was the first case of its type I had seen, and partly because it provided a dramatic diagnostic surprise. It may be conveniently quoted here, as it gives a graphic picture of these retroperitoneal cysts.

*Case 1.*—Female, 34, married, with two children, was admitted to St. Mary's Hospital with a history of vague pains in the left side of the abdomen. She had had a certain amount of trouble with the bowels for the previous month, necessitating the use of purgatives twice a week, but we were not satisfied that this was of any importance. She had also had frequency of micturition for about three months, which she described as coming in regular attacks with quite normal intervals. On examination, a swelling was found in the left side, being freely movable and easily reduceable into the loin. It was soft, rather flabby, and obviously cystic in nature, and I think quite naturally a diagnosis of hydronephros was made. A pyelogram was accordingly taken, but unfortunately the plate was thin, and no definite expression of opinion could be hazarded upon it. It was, however, suggested that the solution seemed to have filled a very small part of the renal pelvis.

An exploratory operation was decided upon, and the left oblique lumbar incision performed. When the perirenal space was exposed, a bluish thin-walled cyst was found, and the diagnosis of hydronephrosis seemed assured. As the dissection proceeded, the surgeon remarked that the ureter would soon be found attached to the hydronephrosis. But the cyst shelled out revealing no attachments at all, and it was then realized that the kidney was present, rather higher in the abdomen than usual, and moreover was only half the normal size, thus explaining the unusual pyelogram.

This case illustrates in many ways the features characteristic of retroperitoneal cysts. The need exists for an accurate definition of the term 'retroperitoneal cyst', for so many cases are so named which are cysts of organs such as the kidney, pancreas, and so on. They are naturally situated behind the peritoneum, but I submit that the term should be reserved for those cysts lying in the retroperitoneal fatty tissues which have no apparent connections with any adult anatomical structure save by areolar tissue.

In this paper I shall deal with such cysts as I have defined above, except that I have a few remarks to make on some falsely-named pancreatic cysts, and also on two cystic conditions in the kidneys which are of developmental origin and are very closely related to the whole question of the true retroperitoneal cyst. I shall therefore outline quite briefly the embryological processes which are relevant.

## II. DEVELOPMENT OF THE STRUCTURES OF THE POSTERIOR ABDOMINAL WALL.

**1. The Pronephros.**—The human pronephros has no excretory function, and can only be regarded as a rudimentary structure. Its appearance is but transitory, and its development is so incomplete that a clear idea of its life history is by no means easy to obtain, especially as it occurs in so very early a stage in the growth of the human embryo, being first seen in a 1.73-mm. embryo and having completely disappeared by the time the 4.9-mm.

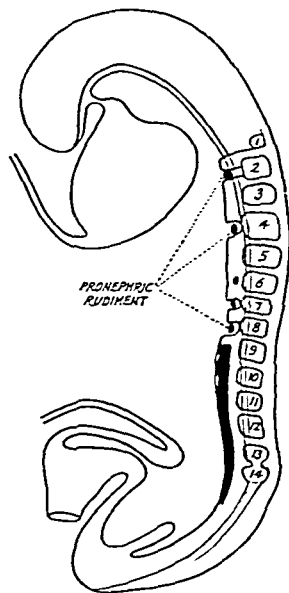
stage is reached. A detailed account of its development would be quite out of place here, but certain of its salient features must be emphasized.

In lower forms the excretory system is essentially a segmental one, and the same tendency is seen in the arrangement of the human pronephros and mesonephros. The segmentation of the mesoderm begins at the head end of the embryo and proceeds caudally until complete. Pronephric rudiments have been seen by Felix<sup>7</sup> and others in the 2nd primitive segments (*Fig. 85*). The cranial portion develops first, and so brief is the existence of the tubules that those first formed are already in an advanced stage of degeneration when the caudal ones are appearing. These latter are completed in an embryo of 2.5 mm. greatest length, and are already degenerated in one of 4.25-mm. vertex-breech length.

For the purpose of this paper two points are of the utmost importance, viz., the most caudal extension of the pronephric system, and the time of its complete disappearance. It is probable that no pronephric tubules exist beyond the 12th primitive segments, though there is some doubt about the 13th pair. The 12th segments will eventually correspond in the developing embryo with the opening of the bursa omentalis, and therefore pronephric remnants—if they persist—will be behind the peritoneum and are in a position to account for cyst-formations. In this connection it is instructive to remember that in the dogfish there are certain papillary projections from the posterior wall of the bursa omentalis, which Professor J. E. S. Frazer has described, and to which he has given an undoubted pronephric value. The time of disappearance of the pronephros is impossible of accurate determination, because in the caudal segments there is an overlapping of pronephric and mesonephric elements, and the picture is somewhat confused; but it may be said with some confidence that by the time the 5-mm. vertex-breech length stage is reached, the pronephros has disappeared. Nevertheless it is important to remember that the external glomerulus of the pronephric tubules may persist long after this stage, because of their independence.

**2. The Mesonephros.**—The development of the mesonephros is a vast subject, and the following description will be confined to a brief outline of its growth, its original extent, its two periods of degeneration, and lastly to its eventual adult representatives.

The mesonephros, developing from the mesoderm of the intermediate cell mass, is first seen in the 13th, 14th, and 15th segments in an embryo of 2.5 mm. greatest length (*Fig. 86*). These segments correspond to the 2nd, 3rd, and 4th thoracic segments. (From now onwards the segments will be



*FIG. 85.*—Diagram showing the left pronephric elements in an embryo of 2.6 mm. greatest length, with 14 pairs of segments. There are pronephric rudiments in the 2nd, 4th, 6th, 7th, and 8th, and the ridge from the 9th to 13th primitive segments. (*Modified from Felix.*)

denominated cervical, thoracic, and lumbar—the reader will remember that the first four pairs of primitive segments are taken up in the development of the head.) Growth occurs in both directions, for, in an embryo of 5.3 mm. greatest length, mesonephric tubules have extended to the 6th cervical segment, and in an embryo of 7 mm. the caudal limits of its extension have been reached, i.e., to the 3rd lumbar segment. It will be seen then that mesonephric elements are developed in the 6th cervical to the 3rd lumbar segments both inclusive, making a total of 18 segments. In these segments the development of the tubules is dysmetameric, and several tubules are formed in each segment. Felix estimates that a maximum of 83 tubules are formed in each mesonephros.

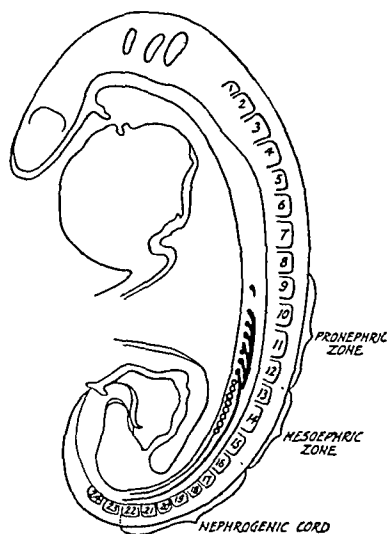


FIG. 86.—Diagram showing the left excretory apparatus of an embryo of 2.5 mm. and 24 pairs of segments. Pronephric elements can be seen in the 9th to 13th segments, mesonephric vesicles in the 13th to 16th, and, caudal to that, the part of the intermediate cell mass which will give rise to the rest of the mesonephros and the metanephros. (Modified from Felix.)

cases one of these may remain as a vestigial structure, and, should it do so, another possible origin of retroperitoneal cysts has been demonstrated (Figs. 87 and 88).

The second period of degeneration occurs later, and is concerned with the remaining 26 tubules, all situated in the lumbar region. The upper group, consisting of the 58th to 69th tubules inclusive, form the epigenitalis, and the lower group of the 70th to 83rd tubules, the paragenitalis. The former are intimately concerned with the development of the genital glands, and are of no importance here. For exactly the same reason the paragenitalis tubules in the male need no description; but in the female the various tubular structures formed in and near the broad ligament are all derived from these paragenitalis tubules. The structures referred to are included under the

The first period of degeneration begins before the caudal extension is complete, for as soon as the cranial tubules are fully developed they begin to degenerate. It therefore starts in the 5.3 mm. stage, and continues until the embryo has reached 21 mm. greatest length. Beginning in the 6th cervical segment, degeneration proceeds in a continuous and regular fashion down to and including the 12th thoracic; 15 segments therefore disappear, and only the three caudal ones persist. In terms of tubules, Felix<sup>7</sup> estimates 57 out of 83 degenerate and should disappear entirely; but a most important fact is emphasized by Zuckerkandl,<sup>15</sup> that remains of these tubules can sometimes be identified long after the normal date of their disappearance. For the purpose of this paper the foregoing facts are of very great importance. The mesonephros in the whole range of its development is lying in the retroperitoneum, and there are 57 tubules which should normally disappear. It is reasonable to suppose that in a certain number of

several names of paroophoron, Kobelt's tubules, etc. Certain retroperitoneal cysts in the pelvis undoubtedly arise in these mesonephric structures.

FIG. 87.—Diagram of the structures of the post-abdominal wall and the pericardium of an embryo of 16 mm., showing the ridge formed by the mesonephros on each side. The ridge is already dividing longitudinally into two, to form the genital gland. The extent of the mesonephros will be seen to be from the top of the retroperitoneum right to the pelvis.

A, Mesonephros; B, Genital ridge; C, Median mesentery; D, Genital tubercle. (Copied by Miss I. C. Mann from a drawing of Prof. J. E. S. Frazer.)

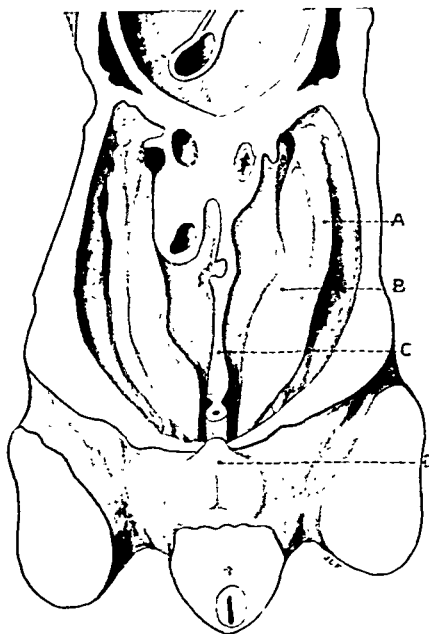
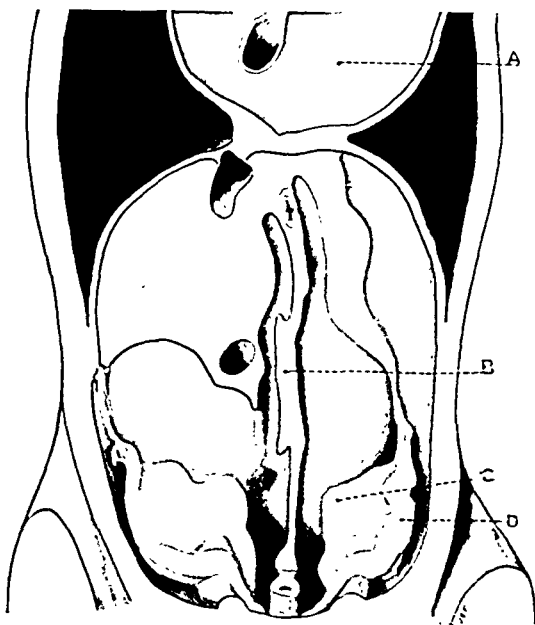


FIG. 88.—Diagram similar to Fig. 87 in an embryo of 28 mm. It shows the degeneration of the mesonephros, the marked growth of the suprarenal; and the line of disappearance of the mesonephros is seen to be from the lateral ligament of the liver down to the internal abdominal ring.

A, Pericardium; B, Median mesentery; C, Genital gland; D, Mesonephros. (Copied by Miss I. C. Mann from a drawing of Prof. J. E. S. Frazer.)





**3. The Metanephros.**—This arises from the nephrogenic cord in its caudal quarter, and is divided embryologically and physiologically into two parts—the excretory and the efferent. The efferent system develops from the Wolffian duct in the 5th lumbar segment, at the point where it turns horizontally forward to enter the lateral wall of the cloaca. From this origin the ureteric bud, first seen in embryos of between 4.5 and 5.3 mm. greatest length, grows at first dorsally towards the vertebral column, and then, gradually curving, grows cranially behind the mesonephros in the retroperitoneum. This cranial growth continues until it held up by the lateral outgrowths, which, acting as an anchor, prevent a further growth forwards (*Fig. 89*). By the 13-mm. stage, the adult position of the renal pelvis opposite the 2nd lumbar vertebra has been reached. Increase in length of the ureter occurs caudally, for it is in the lumbar region that the body growth principally takes place. The ureteric bud divides into two poles, and these begin growing on their

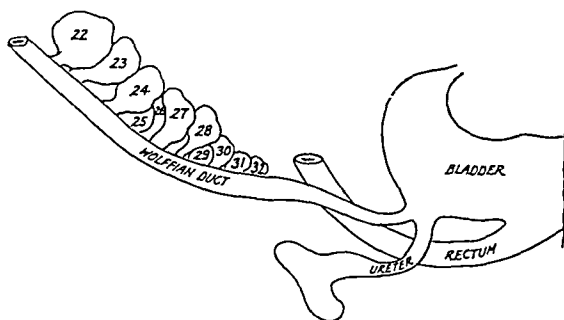


FIG. 89.—The right side of an embryo of 9.5 mm. greatest length, in which the ureteric bud has formed a primitive pelvis, and has divided into its first two tubules. (*After Felix.*)

own account; so are the collecting tubules of the first order formed. These again form collecting tubules of the second order, and so on and so on, until there are formed tubules of the 1st to the 12th order and terminal collecting tubules. The final completion of this series occurs during the fifth month.

The excretory system arises in that part of the nephrogenic cord which lies in direct sequence with, and caudal to, the last mesonephric segment. In the human embryo it is quite small, and on the formation of the ureteric bud lies internal to it; but it rapidly grows around the ureteric bud, and provides it with a cap. When the collecting tubules of the 1st order form, the metanephric cap divides, keeping pace with the tubules, thus providing each set with a cap of excretory tissue. And so the process advances with every formation of a new order of collecting tubules, until at last all 12 orders of tubules are formed, each with their own excretory cap. At this stage, so closely packed together are the branches of this ureteric tree, that the contiguous islands of excretory tissue all coalesce, and the first representation of the formed kidney is now obtained. From the excretory caps are formed Bowman's capsules and the uriniferous tubules.

It is clear, therefore, that union must take place between the terminal collecting tubules and the uriniferous tubules before the function of the kidney can be established. There is apparently a union of some tubules in one of the earliest orders; but the view held by Felix is that the final union occurs much later. However accomplished, this union is a most complicated process, and for this reason slight disturbances of development may give rise to quite marked anomalies.

The account here given is the commonly accepted theory as so ably expounded by Felix; but it is not possible to leave the subject without referring to the work done by O. F. Kampmeier<sup>12</sup>, who has brought forward an entirely new conception of the development of the kidney. He suggests that, in the metanephric caps surmounting the collecting tubules of the 1st order, uriniferous tubules are developed and unite with the collecting tubule. These uriniferous tubules then undergo cystic degeneration and disappear. With the formation of collecting tubules of the 2nd order, uriniferous tubules of the 2nd order develop and unite with the collecting tubules. Again there occur cystic degeneration and disappearance. And so the process continues up to the final order of tubules. If Kampmeier's account be true, it must be obvious that there are enormous numbers of tubules which are formed only to undergo cystic degeneration and death, and therefore the possibilities of such degenerated areas remaining instead of disappearing completely are very great. It seems probable that the origin of certain cystic diseases of the kidney must be sought much earlier in their developmental history than has been previously thought. As will be explained later, single large cysts of the kidney are much easier of explanation by Kampmeier's work than they were before.

4. **The Wolffian Duct.**—The Wolffian duct is the primary excretory duct of the pronephros and mesonephros. Arising originally by the fusion of the pronephric principal tubules, it is joined later by the similar mesonephric tubules. It terminates in the lateral wall of the cloaca, and, as has been explained, gives origin to the ureter bud. During the degeneration of the pronephros and mesonephros, the duct keeps pace with that process. In the male, it is represented by the ducts of the epididymis and the vas deferens; in the female it survives only as the duct of Gartner.

5. **The Müllerian Duct.**—This duct develops primarily from an invagination of the coelomic mesothelium into the summit of the urogenital fold in the region of the 2nd and 3rd thoracic segments. It is present in embryos of 10 mm. greatest length, and represents the ostium abdominale. From the blind end of this pouch a caudally directed outgrowth takes place, immediately external to the Wolffian duct, i.e., between it and the coelomic mesothelium. That is the commonly accepted view, though Professor Frazer suggests that there are grounds for believing that the Müllerian duct is really derived from the Wolffian duct by a process of gradually advancing separation, a state of affairs well recognized in lower forms. The Müllerian duct disappears practically entirely in the male, but is, of course, the main groundwork of the architecture of the female generative organs.

### III. THE DEVELOPMENT OF THE PERITONEUM OF THE POSTERIOR ABDOMINAL WALL.

I now pass to the development of the peritoneum of the posterior abdominal wall, and particular emphasis will be laid upon it, because I believe that in anomalies of its formation there exists one of the causes of retroperitoneal cysts. As far as I can gather from my reading of the literature, this origin has not been touched on before. My attention was first called to this

possibility by a suggestion from Professor Frazer, and this part of my paper has resulted from our many discussions of this subject.

It is the peritoneal relations of the large intestine to which I wish to draw attention, and I cannot make my point clear unless I touch briefly on the return of the intestine from the umbilical sac and the rotation of the intestine, which the former so largely influences.

**1. The Return of the Intestine within the Abdominal Cavity.**—It will be seen from *Fig. 90* that in a 35-mm. embryo the mass of intestines is still in the umbilical sac, which is shown opened, exposing the contents *in situ*. It will be appreciated that the colon lies in the left part of the sac, and enters the abdomen to the left of the proximal loop; and further, it can readily be seen that the colon and its mesocolon can be considered in two parts, viz.,

the abdominal and umbilical. The abdominal mesocolon stretches from the neck of the sac to the posterior abdominal wall in the mid-line, and therefore acts as a median septum in the upper part of the abdomen. This is a feature of the highest importance.

Frazer and Robbins,<sup>s</sup> in their admirably lucid paper on the factors concerned in the rotation of the intestine in man, have developed a reasoned argument to explain the mechanism by which the intestine returns and takes up its eventual adult position. They point out that the return

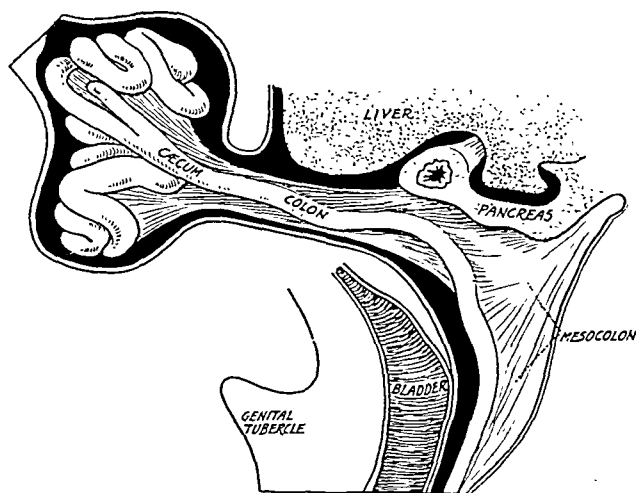


FIG. 90.—Drawing of a section through an embryo of 35 mm. just to the left of the middle line, seen from the left. The umbilical sac is opened and the intestine seen *in situ*. The cæcum and appendix will be seen in the left of the sac, and the returning colon is on the left of the proximal loop. The abdominal colon and its mesocolon are well shown. (From a reconstruction by Frazer and Robbins.)

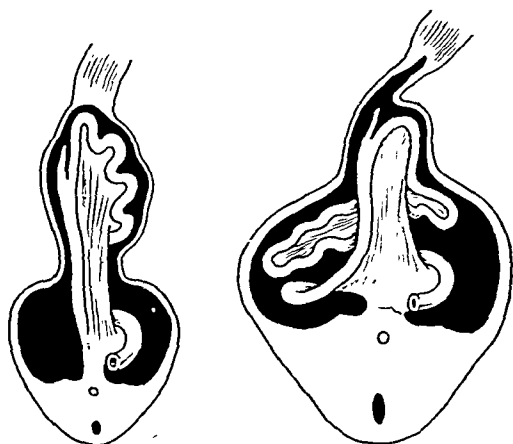
is a rapid—almost instantaneous—process, and is brought about by the changes in relative pressures of the abdominal cavity and amniotic sac. They proceed to show that the return begins with the proximal loop, followed by the next coil, and the next, and so on, until at last only the cæcum remains, and on its return that step in the whole process is complete.

The disposition of the returning loops follows a definite plan, and has far-reaching effects upon the development of the peritoneum of the posterior abdominal wall. If it be recalled that the proximal loop in the neck of the umbilical sac lies to the right of the distal or colic loop (*Fig. 90*), and that the abdominal mesocolon forms a median septum, it follows that the returning loop must necessarily pass to the right of this septum, and will then lie below the right lobe of the liver. As more intestine returns, the mesocolon is displaced dorsally and to the left, and the coils come to lie ventral to it, and

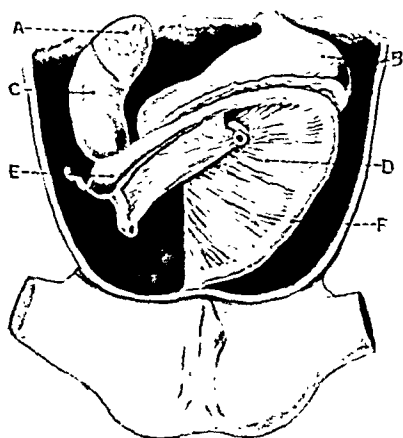
below the cæcum and ascending colon, which are still in the sac. When this part of the gut returns, it will lie above and ventral to the coils of small intestine and below the liver (*Figs. 91 and 92*). It has naturally turned towards the right, thus coming into line with the distal part of the colon. As the coils increase rapidly in length, the cæcum is pressed back until it reaches the dorsal wall, on which it lies, but to which it is not adherent.

## 2. The Method by which the Colon gains its Adult Position: the Mesocolon.

The foregoing description has brought the cæcum and the ascending and descending colon into relationship with the posterior abdominal wall, but they have not yet reached their adult position. This is seen in an embryo of 55 mm. (*see Fig. 93*). It remains to describe how this is brought about. *Fig. 94*

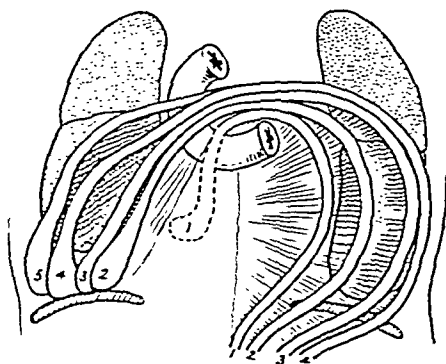


*Figs. 91, 92.*—Diagrams of abdominal cavity and umbilical sac seen on section from above, to illustrate the mechanism of the laying down of the mesocolon on the posterior abdominal wall (*see text*). (*After Frazer and Robbins.*)



*Fig. 93.*—Drawing of an embryo of 61 mm. dissected to show the mesocolon. The small intestine has been removed. The cæcum is seen on the posterior abdominal wall, but not adherent, and the descending colon is shown well out towards the flank, but not adherent. It is held up by a glass rod. The mesocolon is well shown, that on the right being derived from the mesentery of the loop, that on the left from the abdominal mesocolon. A. Suprarenal; B. Stomach; C. Kidney; D. Mesocolon; E. Cæcum; F. Descending colon.

*Fig. 94* explains diagrammatically the extension of the colon. No. 1 represents the position in a 45-mm. embryo, No. 2 that in a 63-mm., No. 3 that in a 125-mm., No. 4 that in a 160-mm. embryo, and No. 5 that in a full-time fœtus. From this it is evident that the whole colon is elongating; the future splenic flexure is travelling



*Fig. 94.*—A scheme from Frazer and Robbins' paper to illustrate the gradual movement of the colon outwards from the mid-line (*see text for description*).

upwards and to the left, and the hepatic flexure to the right and less markedly upwards because of the liver; with this there occurs an extension in the area of the mesocolon, and it is to the ascending and descending colon that particular attention will now be drawn. When the ascending and descending colon with their mesocolon are swung back upon the posterior abdominal wall, it is evident that three layers of peritoneum must be in contact, viz., the peritoneum of the posterior abdominal wall and the two layers of the mesocolon. It follows that, for the adult arrangement to be produced, two of these layers must disappear, leaving the gut fixed on the abdominal wall. The two layers to go must be the posterior one and the middle one. The contention here raised is that, should these two layers fail to disappear completely, small islands of peritoneum will remain behind the peritoneum, and that these may act as the *Anlage* of a retroperitoneal cyst.

#### IV. CLASSIFICATION AND DESCRIPTION OF CYSTS OF VARIOUS ORIGINS.

Having briefly outlined certain embryological processes, I now turn to a description of the several varieties of retroperitoneal cysts, and will therefore suggest a classification of them. It may not be exhaustive, and is assuredly open to criticism; but it does, in my opinion, cover the ground, and, moreover, deals with the subject on an embryologico-anatomical basis, which I believe to be the correct one.

- |  |   |   |
|--|---|---|
| A. Cysts of urogenital origin                          | { | 1. Pronephric<br>2. Mesonephric<br>3. Metanephric<br>4. Müllerian |
| B. Cysts of mesocolic origin                           |   |   |
| C. Cysts arising in cell inclusions—Teratomatous cysts |   |   |
| D. Lymphatic cysts                                     |   |   |
| E. Traumatic blood cysts                               |   |   |
| F. Parasitic cysts                                     |   |   |
| G. Cysts of developmental origin in                    | { | 1. The kidney<br>2. The pancreas                                  |
| fully-formed organs                                    |   |   |

Some of these almost explain themselves, but a short description of them all will be given.

##### A.—Cysts of Urogenital Origin.

*Naked-eye Appearance.*—When first exposed and seen *in situ*, they appear as bluish thin-walled cysts and rather flabby, never being tightly distended. When removed they are translucent and lose their bluish tinge. There are no visible vessels in their walls; they have no demonstrable pedicle and no connections—save by areolar tissue—with the surrounding structures. When opened they have a smooth, glistening lining membrane; are single, not multilocular; and contain a clear serous fluid of low specific gravity, in which there is occasionally cholesterolin.

*Microscopic Appearances.*—The wall is thin and consists of a cellular fibrous tissue lined by epithelium, which is usually of a low columnar type, but may be cubical, and rarely is flattened. In one section in my possession the columnar epithelium contains one or two goblet cells, which stain with

muci-carmine. The cells are small, have well-staining nuclei, and a cytoplasm which stains faintly with eosin.

*Situation.*—From a study of the development of the urogenital system, it is clear that these cysts will occur in an area bounded above by the lateral ligament of the liver, below by the internal inguinal ring, internally by the outer margin of the psoas magnus muscle, and externally by the lateral abdominal wall. A second area lies in the pelvis along the line of the vas deferens in the male and the broad ligament in the female. The majority of the reported cases occur near the kidneys or behind the colon, and near the head or tail of the pancreas.

The question must inevitably arise as to the identification of such conditions, when a retroperitoneal cyst is met with in a patient. Can a cyst be established beyond question to be of urogenital origin? I think not, though their situation and histology are suggestive. The fact remains that there is nothing absolutely conclusive about their histology, and no dogmatic expression of opinion is justified. I hope, however, I may claim that I have demonstrated that there are ample possibilities of remnants of this embryologic system to render such an origin probable; but even if this premise be accepted, it is still difficult to establish from which part of the system any particular cyst has arisen. It can be said, however, that a cyst lying above the plane of the foramen of Winslow is either pronephric or mesonephric in origin, those below that level either mesonephric or metanephric. And when cysts are found near to an unusually small kidney, then there are strong grounds for assuming that the cyst is of metanephric origin. My first case and that reported by Frazier<sup>9</sup> are examples of this type.

On the subject of cysts of the female pelvis, very little doubt need be entertained. Those occurring in or near the broad ligament are well recognized, and have been given various names by gynaecologists. They had much better be designated broad ligament Wolffian cysts, for they are undoubtedly of mesonephric origin.

Fimbrial cysts are, of course, Müllerian.

*Case 1* has already been described. *Case 2* occurred in the practice of my father's partner, Dr. Cowper, of Shanklin, Isle of Wight, to whom I am indebted for the details of the case and the microscopic preparations. As will be seen, the record is not quite complete, for I have had to rely upon a description of the case.

*Case 2.*—A girl of 15 years had a sudden transient symptomless hæmaturia lasting thirty-six hours, succeeded three months later by an exactly similar attack. Dr. Cowper was then asked to see her, and a swelling was found in the left side of the abdomen, rather high up and partly under cover of the left costal margin. The swelling was soft and apparently cystic, and an exploratory laparotomy was decided upon. A large cyst was found pushing the stomach and transverse colon in front of it, and coming apparently from the back of the abdomen. Considerable difficulty was experienced, but it was traced back to the neighbourhood of the left kidney. Attached to its deepest part were three tubules, each about the size of a normal vas deferens. The cyst and tubules were removed, but unfortunately it was not possible to define the exact connections of these tubules. The wound was closed, a rubber tissue drain being inserted. The patient stood the operation well, and all went well until, on the third day, there was a clear discharge from the wound. The next day this had become more copious, and was soon recognized as urine.

This urinary fistula continued for some weeks, until a left-sided nephrectomy was performed. The wound then healed without difficulty.

The cyst itself was typical in its naked-eye appearance, but the wall contained a thin layer of unstriated muscle fibres. The contents were clear fluid, but were not examined chemically. One tubule was sectioned, and showed the same structure as the cyst wall. Both had a lining of very rudimentary epithelium, which was only present in small areas.

The kidney was described as small, and infantile in type, being markedly lobulated, but no obvious lesion could be found in it. That it had some connection with the cyst seems indisputable, but the exact nature of that connection cannot now be stated. It seems probable that this was some anomaly in development of the excretory system, but beyond that it is not possible to go.

Cases similar to *Case 1* are reported by Ashhurst,<sup>2</sup> Lapointe,<sup>13</sup> Frazier,<sup>9</sup> Elder,<sup>5</sup> Elter,<sup>6</sup> and others.

Cysts of urogenital origin occur in both sexes, but more commonly in women. They are seen between the ages of 10 and 50, but the decade 15-25 provides most of the cases. The left side of the abdomen is more frequently affected than the right.

**B. Cysts of Mesocolic Origin.**—In general appearance these will resemble the urogenital cysts described above, and are composed of a fibrous wall lined by a delicate flattened epithelium. They are found only in the area between the ascending and descending colon and below the transverse mesocolon. When they are removed they show little to distinguish them, but while still *in situ* one anatomical relationship will decide the question. Mesocolic cysts will lie anterior to the spermatic or ovarian vessels, while urogenital ones will be posterior to them. This is a point worth investigating during an operation on these conditions.

*Case 3.*—Post-mortem case, male, age 64, death due to heart failure after a preliminary suprapubic cystostomy for enlarged prostate. A small cyst was found lying behind the peritoneum and in close contact with it, to the inner side of the descending colon, and near the spermatic vessels. It consisted of a thin fibrous wall, lined in some places only by a fine, flattened epithelium. (Many of these cysts are reported as having no lining membrane at all, but traces of one can usually be found after prolonged search.) This cyst is either mesocolic or lymphatic in origin.

**C. Cysts arising in Cell Inclusions.**—The teratomatous cyst—commonly known as the dermoid cyst—is found not infrequently in the retroperitoneal tissues. Two of my cases were of this nature, and a third I owe to the courtesy of Dr. Robert Knox and Dr. Harrison Orton. Their structure is well known, being composed of a fairly thick cyst wall, and containing usually an intracystic prominence upon which may be found teeth and hair. The cyst is usually filled with sebaceous material and hairs.

*Case 4.*—Woman, age 62, had vague indefinite pains in the lower part of the abdomen and in the back for several weeks. She had a bad attack of diarrhoea fourteen days before admission. On examination, a rounded swelling was felt in the neighbourhood of the caecum. Typical 'dermoid' cyst removed from behind the caecum.

*Case 5.*—Age 59, with a very similar history to the above. In this case a cyst was found behind the peritoneum near the hepatic flexure. It contained sebaceous material and hairs, and was lined by squamous epithelium.

**Case 6.**—(Dr. Robert Knox's case). Discovered unsuspected in the course of a barium meal examination. It was found to be attached to the anterior aspect of the head of the pancreas.

The origin of the teratomata has been the subject of many theories and much criticism. No useful purpose would be served by a discussion of such theories here; but retroperitoneal dermoids are among the rarer teratomata, occurring as they do outside the genital system, and it is these extra-genital cases that have discredited several theories that might explain ovarian or testicular tumours, but which could not account for the remainder. There is one theory that has not obtained that prominence to which it is justly entitled, viz., *Felix's strayed genital cell theory*. In the past most embryologists have accepted the view that the genital cells arise in the coelomic mesothelium of the genital ridge of the urogenital fold; but the modern view suggests that the primary genital cells are of much

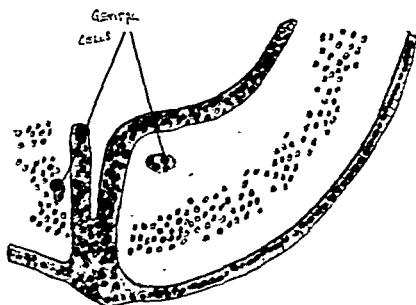


FIG. 95.—The cloacal region of an embryo of 2.5 mm. greatest length. Two multinucleate genital cells are seen near the cloacal membrane. (After Felix.)

earlier origin than this, being derived from the segmentation cells. Fig. 95 shows two such primary genital cells in the region of the cloaca in an embryo of 2.6 mm. with 13-14 pairs of segments, and Fig. 96 shows one in the root of the mesentery in an embryo of 4.7 mm. with 33 pairs of segments. It follows that, in order to reach the *Anlagen* of the genital glands, these

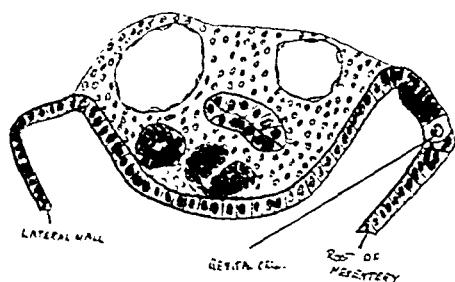


FIG. 96.—Section through the 11th primitive segment of an embryo of 4.7 mm. in length. It passes through the urogenital fold, and shows a primary genital cell in the root of the intestine. (After Felix.)

cells have some distance to travel. It is doubtful if they all reach their goal, and the possibility of some 'strayed' genital cells must be admitted. These cells are totipotent cells, and therefore are possible sources of teratomata. The retroperitoneal cases are all found somewhere near the root of the mesentery, and that would appear suggestive, for the root of the mesentery is the commonest place for these genital cells to be found in very young embryos.

**D. Lymphatic Cysts.**—These fall into two classes: those formed in the lymphatics returning from the intestine, and those arising in the lymphatic field behind the peritoneum and not connected with the intestine. The first group are known as chylous cysts, and have been fully dealt with by many observers. The second class occur as single cysts of varying size, and are exactly analogous in their origin to the single cystic lymphangioma seen in



the neck. Hadley<sup>11</sup> believes them to be due to anomalies in development of the primitive lymph sacs of the abdominal cavity. Gaudier and Gorse<sup>10</sup> report a case of a very large lymphatic cyst in a boy, age 4, which occupied the iliac fossa and spread through the inguinal canal into the scrotum. Small multiple lymphatic cysts are sometimes seen, particularly in the pelvis, and my colleague, Mr. Aleck Bourne, tells me that he has frequently seen them in the course of gynaecological operations, and that he is convinced of their lymphatic origin.

**E. Traumatic Blood Cysts.**—Chardon<sup>3</sup> records a case of a girl, age 14, who had fallen and injured her right side two years previously. Nothing serious was noted at the time, but when first seen by him she was found to have a cystic swelling in the right side of the abdomen. At operation a typical blood cyst was found in the retroperitoneal tissues behind the ascending colon. Such cysts are due to a hæmatoma resulting from an injury. These cases will usually be brought to operation as an emergency; but should they not be large enough to cause sufficiently acute symptoms, the development of a blood cyst is a well-recognized result.

**F. Parasitic Cysts.**—The hydatid cyst stage of the *Tania echinococcus* is not infrequently seen in the retroperitoneal tissues. It may reach such a situation either by the blood stream, by transcælotomic implantation after the rupture of a cyst in the liver, for example, or by penetrating the intestinal wall at that situation. There is a beautiful specimen in the Royal College of Surgeons Museum in the female pelvis, and another in the Museum of St. Mary's Hospital in the male pelvis. The latter is a good example of the curious symptoms for which these retroperitoneal cysts may be responsible. It was behind the prostate and bladder, and had become impacted in the pelvis. As a result it had pushed the prostate forward, kinking the urethra as it passed through the triangular ligament, and caused chronic urinary obstruction.

**G. Cysts of the Pancreas and Kidneys.**—In my introduction to this paper I emphasized that the term retroperitoneal cysts should be applied only to those cysts lying in the fatty tissue behind the peritoneum, attached to their surroundings by areolar tissue only. I do not propose, therefore, to deal at length with cysts of the pancreas and kidneys; but these few remarks will not come amiss, I think, in this place. With regard to pancreatic cysts, Primrose<sup>14</sup> in 1922 pointed out that the description and the nomenclature of these cysts in and around the pancreas was most confused and unsatisfactory. When true cysts of the pancreas are mixed up with 'pseudo-cysts' and parapancreatic cysts, the ordinary reader is entirely misled. Again, Donoghue<sup>4</sup> in 1906, in reviewing the whole ground, analysed twenty reported cases of pancreatic cysts, and could find no evidence that any one of them was really pancreatic in origin. The neighbourhood of the pancreas is one which is favourable for the location of developmental cysts, and I submit that no cyst should be called pancreatic unless it contains pancreatic tissue in its walls or in its pedicle.

With regard to the kidney, two cystic conditions found therein are of developmental origin. The congenital polycystic kidney is well known, and

needs no description. The earlier remarks upon the development of the metanephros will have made clear the two possible methods of its origin. The single cyst of the kidney is, however, quite a different proposition. The commonly accepted theory of the union of the uriniferous tubules with the later orders of collecting tubules could never explain the existence of a large single cyst which had replaced one quarter or more of the kidney; but Kampmeier's theory makes the origin of such a cyst quite clear, for it is easy to understand how a cystic dilatation of one of the second order of collecting tubules could bring about a single cyst with lack of development of that part of the kidney.

## V. DIAGNOSIS.

From the foregoing descriptions it will be readily appreciated that the diagnosis is often extremely difficult, and, with the exception of the traumatic blood cysts and the parasitic cysts, there will be little in the history to help. It is, in fact, the very vagueness of the story, the indefiniteness of the signs, and the absence of symptoms typical of other conditions, e.g., the hydro-nephrosis, that should raise the suspicion of a retroperitoneal cyst. In *Case 1* vague symptoms pointed to two systems, the intestinal and the renal, but neither could be really suspected with any confidence. In those cysts which lie in the loin, a pyelogram will be undertaken as a routine, and in this investigation we have a small hope of a diagnosis. Should the photograph show an unusually small pelvis with only two calices, and should there be a cystic and movable swelling in the loin, then I suggest that the diagnosis may be made with some degree of confidence.

Pelvic cysts can be much more readily diagnosed by a thorough bimanual examination, but in the majority of cases the diagnosis will probably be that of an ovarian cyst.

## VI. TREATMENT.

These cysts should be removed, access being gained by the most convenient route, through the loin or through the anterior abdominal wall. The loin approach will in many cases give the best exposure, but cysts near the pancreas will demand a laparotomy. The developmental cysts will shell out with the greatest ease. The only one to give trouble will be the parasitic cyst, especially if it is infected. It will rarely be necessary to marsupialize any of them, and for this reason the cysts near the pancreas should be carefully investigated, for all those not truly pancreatic will shell out, and a marsupialized sac will thus be avoided in certain cases.

## CONCLUSIONS AND SUMMARY.

I hope I may claim to have presented an accurate classification and a detailed description of these cysts, and a reasonable explanation of their origin. One entirely new possibility has been suggested and supported on embryological grounds. It has been my aim to show how an intimate knowledge of embryology may make clear certain obscure etiological problems. If

it serves to stimulate a closer correlation between the work of the embryologist and the pathologist I shall be satisfied. This has been the principle which has inspired this paper throughout.

My thanks are due to Professor J. E. S. Frazer for his helpful criticism, for permission to use some of his diagrams, and for showing me much of his embryological material. I am also indebted to Mr. W. H. Clayton-Greene, Mr. D. C. L. Fitzwilliams, and Dr. Cowper, for permission to publish cases. To Dr. Robert Knox I owe one of my cases with his X-ray photographs, and to him I offer my sincere thanks. Dr. E. H. Kettle I have to thank for the facilities he has always given me for working in his laboratory, and to him, to Mr. Clayton-Greene, and to Professor Charles A. Pannett I am increasingly indebted for their encouragement and helpful criticism.

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## SOME ACTIONS OF RADIATIONS ON LIVING TISSUES.

BY CECIL P. G. WAKELEY, LONDON.

*(Being the Arris and Gale Lecture delivered at the Royal College of Surgeons of England on February 18, 1924.)*

THE earliest observations upon the action of X rays on the tissues were made upon X-ray workers who were found to develop a peculiar form of dermatitis as a result of continued exposure to the rays. The phenomena attending X-ray dermatitis are too well known to need recapitulation here; but *Figs. 97 and 98* may be of interest as showing the development of a malignant neoplasm as a sequel to continued exposure after the patient had received an X-ray burn.



FIG. 97.—This shows a neoplastic ulcer on the finger of an X-ray worker, resulting from prolonged exposure to the rays.

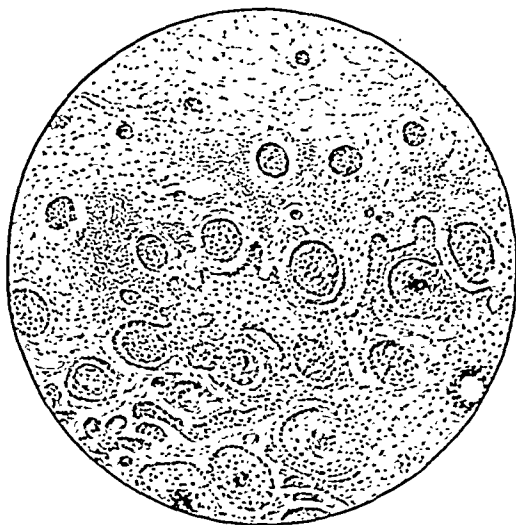


FIG. 98.—Microscopic section of the margin of the ulcer depicted in Fig. 97. It shows hyperplasia of the inter-papillary processes and proliferation of the prickle-cell layer. There is a definite round-celled infiltration and some fibrosis.

That radium salts could produce effects upon the skin similar to those caused by exposure to X rays was noted as early as 1900, while in the following year Becquerel accidentally demonstrated the effect on his own person by carrying an insufficiently protected tube of radium bromide in his waistcoat pocket. The glass tube, which measured  $15 \times 3$  mm., was wrapped in paper, enclosed in a little cardboard box, and deposited in M. Becquerel's pocket, where it remained for some hours. A week later an area of redness measuring  $6 \times 4$  cm. made its appearance upon the abdominal wall. The inflammation

progressed, eleven days later the skin disappeared, and an ulcerated surface remained which did not completely heal for a month.

A large amount of experimental work upon animals has been carried out in connection with the action of radium rays upon the skin. The animals employed included pigs, guinea-pigs, and mice, while the amount of radium salt varied from 6 mgrm. of the sulphate to 130 mgrm. of radium-barium bromide. The radium capsules were covered with mica or thin aluminium, and in one case a 'varnish' applicator was used. In all cases there was a latent period between exposure to the rays and the appearance of any visible reaction. As an example of this experimental work we may briefly summarize some researches of Halkin upon the skin of young pigs.<sup>1</sup>

The radium capsule, which contained 130 mgrm. of radium-barium bromide, was closed by an aluminium covering 1 mm. in thickness. This was placed in immediate contact with the skin, secured with adhesive plaster, and allowed to remain for two hours. On the eighth day after exposure, the first visible evidence of reaction was noted as a livid spot disappearing under pressure. The maximum change was seen between the twentieth and the twenty-fourth days. About this time the surface of the irradiated area had a bluish livid tint, with areas of yellow pigmentation and patches of desquamated epidermis. In the centre of the area the inflammatory changes were more marked, and a small dry scab covered an ulcerated surface. The changes subsequently became more definitely reparative in character, and all that was noticeable on the thirty-eighth day was a slightly pigmented diffuse mark with some desquamation.

Another series of pigs was exposed to radium in exactly the same manner and with the same capsule of radium-barium bromide. In this case, however, the exposure was only for one hour. The reaction was longer in appearing—fifteen days—was of less intensity, and disappeared sooner than in the two-hour series.

**Radium Dermatitis** (*Figs. 99, 100, 101*).—Radium dermatitis, being much less common than the condition produced by X rays, has received small attention in this country, although the Americans have considered the matter in some detail. It is only within recent years that the ultra-violet and chemical rays of the spectrum have been appreciated as the more important agents in the production of many common clinical conditions. Previously erythema solare and the common freckle were attributed to the heat of the sun. It was also noticed that certain cases of lupus erythematosus suggested that light was the determining factor in the site of the eruption. Hydroa aestivale belongs to the same group of diseases. The production of pigmentation by means of the carbon arc in the latest type of treatment in lupus vulgaris is merely another instance of the importance of the rays at the violet end of the spectrum.

Clinically the pictures produced by excessive exposure to the X rays and to radium are indistinguishable. This is to be expected when it is remembered that the  $\gamma$  rays of radium are in juxtaposition in the spectrum with, and overlap, the X rays. The important fact is demonstrated by the following case:—

Mr. —, age 65, has been handling radium salts continuously since 1904. During 1913 he noticed for the first time a little roughness of the hands; at

the same time he experienced a tingling sensation in the fingers. The war saw a very considerable increase in the amount of material that passed through his hands, with the result that in 1916 his hands became discolored and his nails began to fissure and were very friable. The first appearance of warts was delayed until 1920, since when they have gradually increased in number.

To-day the skin of both hands is atrophic, thin, dry, and wrinkled; there are scattered about numerous small patches of lightish-brown pigmentation. Dilated capillaries form a thin network over the surface. There are present



FIG. 99.—Photograph of both hands, showing atrophic pigmented skin with telangiectases and warts. Striation and fissuring of the nails is well marked.

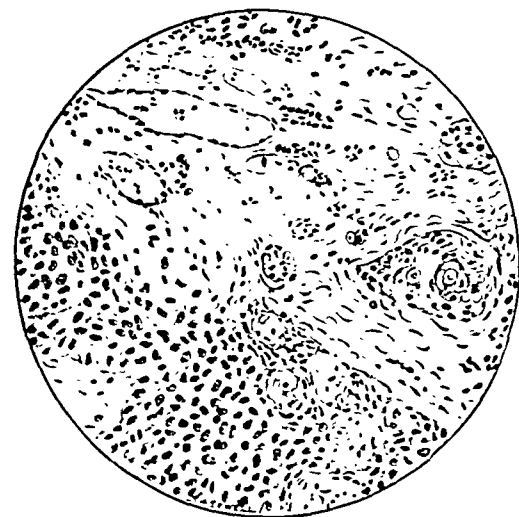


FIG. 100.—High-power view of the centre of the wart. There is extensive epithelial proliferation, with degeneration and vacuolation of the cells. Early invasion of the corium by the epithelial cells is well seen.

being on the third digit of the left hand, and its size less than that of a threepenny piece. No ulcers are anywhere present. The nails are all thinned, striated, fissured, and brittle. The nail bed at its free edge is markedly thickened. Great stress has been laid on this phenomenon as being characteristic of radium dermatitis, and indeed it is the only means of distinction between it and X-ray dermatitis.

For histological purposes the largest wart was excised under local anaesthesia. The wound healed well. The picture presented under the microscope is that of chronic inflammation, together with very early squamous-cell carcinoma. The stratum corneum is markedly thickened, but most of its cells have been

lost over the centre of the wart. The stratum granulosum is not very distinct. The interpapillary processes are prolonged downwards to a marked

extent, as well as showing some branching. There are numerous cell nests, and a few squamous cells are very definitely seen to be invading the corium. The condition is one of early, but yet unmistakable, malignancy. The cells in the centre of the processes are in places definitely degenerate; many others are swollen and show apparent vacuolation around the nuclei; whether this is true vacuolation or œdema of the cells is not clear. Among the prickle cells a few mitotic figures were observed. Even where karyokinesis was not evident, the nuclei varied greatly in size, the larger of them presenting a very active appearance.

The superficial layers of the corium are œdematous, whilst the deeper layers show a definite increase in the white fibrous tissue. In places a slight secondary leucocytic infiltration is present. But far and away the most important feature is the destruction of the elastic tissue; in many places it is

absent, whilst when present it is completely disrupted and is seen as short twisted fibrils. This striking result of excessive radiations will be better appreciated when it is realized that the accompanying illustration (*Fig. 101*) portrays the field in which most elastic tissue was observed.

Thus, it is seen that radium and X-ray dermatitis are exactly similar, and indistinguishable both clinically and histologically, except for the subungual hyperkeratosis seen in the former condition.

The process of healing in cases of damage caused to the skin by exposure to radium manifestly depends upon the amount of damage which has been produced. In some cases

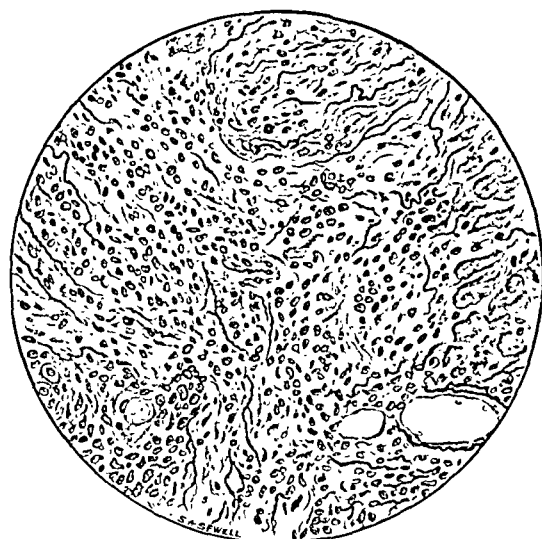


FIG. 101.—A section stained to demonstrate the destruction of the elastic tissue in the corium.

only the hair follicles and sweat glands are permanently destroyed; in more extreme cases attended with ulceration, the ulcer heals in the ordinary manner with the formation of fibrous tissue.

**The Action of the X Rays on the Developing Chick Embryo.**—The first experiments upon the effects of exposure of chick embryos to the X rays were those of Gilman and Bactjer<sup>2</sup> in 1904. Here the observers recorded an initial acceleration of development, followed by retardation and the production of abnormal forms. Bordier and Galimard<sup>3</sup> in 1905 obtained inhibition of development as a result of exposure, as also did Gaskell in 1911. In 1922 a series of experiments by Drs. H. A. Colwell,<sup>4</sup> R. J. Gladstone, and myself were carried out at King's College Hospital. The object of these experiments was to ascertain the action of rays of different degrees of 'hardness' upon developing tissues. The chick embryo was selected as the subject of experiment, and

a series of 36 fertilized eggs were subjected daily to irradiation for a period of eight days. These were divided into four series, which received one pastille dose,  $\frac{1}{3}$ ,  $\frac{1}{2}$ , and  $\frac{1}{4}$  of a pastille dose respectively daily. The same series of screens were used in all the experiments; they were aluminium screens of  $\frac{1}{2}$  mm., 1 mm., and 2 mm. in thickness.

Our conclusions were that in chick embryos irradiated immediately before incubation and then subjected daily to irradiations for several days, the following results were obtained: The action of the rays was in all cases inhibitory, irradiated embryos being invariably smaller than controls. Within the limit of radiation investigated, the effects seem rather to depend upon the total amount of radiation reaching the embryo than upon its quality or 'hardness'. In the series which received a full pastille dose, 6 out of 9 specimens examined showed no sign of development at all. As regards the susceptibility of individual tissues and structures to these conditions, this was found to be most marked in the surface ectoderm, the central nervous system, and the eye.

Further experiments have yielded results which indicate that exposure of embryos which have been allowed to incubate normally for a period of ninety hours, and which have then been exposed to X rays for three successive days, produces in some cases a certain degree of stimulation as indicated by a slight increase in size. These investigations are still in progress.

**The Effects of X Rays on the Skin of the Frog Tadpole.**—These experiments were carried out at King's College Hospital, and their object was to ascertain the effects of prolonged irradiation upon the rapidly-growing tissue at different periods after exposure, and also to see in what manner these effects are modified by irradiation in the presence of colloidal silver. In the latter case, the effects produced are due not only to the action of the primary beam, but also to the soft secondary radiations given off from the minute colloidal particles of the metal.

For the purpose of experiment, frog tadpoles were used; these were exposed to the unscreened radiations from a Coolidge tube working at 2 ma. with a 7-in. spark-gap. In most of the experiments the animals were exposed in  $1\frac{1}{2}$  in. of water in open glass dishes, the distance of the anticathode of the tube being  $6\frac{1}{2}$  in. from the surface of the water. As the tadpoles tended to lie at the bottom of the vessel, it is clear that there must have been a certain amount of 'screening' from the superjacent layer of water. In order to diminish this factor, other specimens were exposed for different periods in about  $\frac{1}{2}$  in. of water, which was changed from time to time during the exposure, so as to eliminate as far as possible any heating effects. The distance of the anticathode from the surface of the water was, as before,  $6\frac{1}{2}$  in. In a further series a small amount (0.04 per cent) of protargol was added to the water containing the tadpoles; in these cases the irradiation was carried out in dishes containing  $1\frac{1}{2}$  in. of protargol mixture, the distance of the anticathode being again  $6\frac{1}{2}$  in. Seven series of experiments were carried out, and histological examination of the skin was performed.

In the normal tadpole skin the epidermis consists of only two layers of cells (*Fig. 102*). Of these, the superficial layer is formed of somewhat flattened cells with more or less oval nuclei, while in the deep layer the cells tend to



become polygonal in outline and the nuclei roughly correspond to the shape of the cell. The pigment cells lie in the corium in close apposition to the subjacent muscle bundles.

The conclusions drawn from these experiments were as follows: In the specimens irradiated immediately after death, very slight changes were noted. Prolonged irradiation within certain limits causes the characteristic changes to appear more quickly; for instance, a specimen killed immediately after

one and a half hours' irradiation showed only some increase in the size of the nuclei of the superficial epidermal layer, together with evidences of increased activity; while specimens which had received two hours' irradiation, and which were killed immediately afterwards, showed slight but definite hyperplasia. Irradiation in the

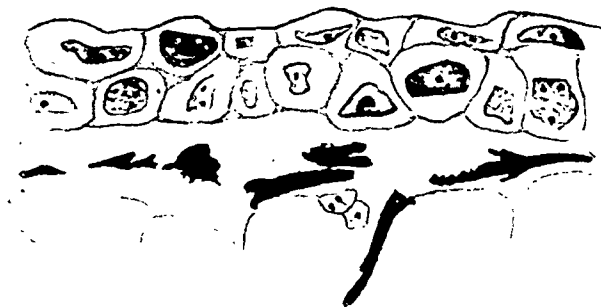


FIG. 102.—Section of normal skin of frog tadpole.

presence of colloidal silver causes much more rapid and profound changes. These were of a markedly stimulative character, within the limits of time after irradiation in which observations were made. (Figs. 103, 104.)

A further series of experiments is being carried out on the skin of frogs and other cold-blooded animals, and will be published in due course.

**Action on Blood-vessels.**—The endothelial lining of the smaller blood-vessels is remarkably sensitive to radiations, the cells becoming swollen, vacuolated, and degenerated, with a tendency to irregular proliferation into the lumen of the vessel. At the same time the vessel wall is infiltrated by leucocytes. From these facts it is clear that exposure to radiations tends to destruction of the blood-vessels, and this explains the clinical use of radium in the treatment of nævi. It shows, moreover, the necessity for care in the clinical use of radium in situations where hæmorrhage cannot be readily controlled and there is reason to suspect the presence of pre-existing degenerative vascular changes.

Exposure to X rays similarly gives rise to degenerative changes in the blood-vessels, and indeed so marked are the changes set up by X rays and radium that they have been regarded as the immediate cause of X-ray and radium burns. Undoubtedly, interference of any kind with the vascular supply to a part must have a greater or less effect in determining the course of any local pathological processes. Vascular changes, however, cannot account for the whole of the phenomenon, and in any case do not afford an explanation of how the vascular endothelium itself comes to be injured.

The changes in the lining cells of the blood-vessels do not occur immediately after exposure to the radiations, but a more or less variable latent period elapses between exposure and its obvious results.

**Effects on the Blood.**—The action of X rays and the  $\gamma$  rays of radium upon the blood has recently attracted a good deal of attention, as it has

been held responsible for cases of severe—and in some instances fatal—anæmia. These occurred among X-ray and radium workers who carried out their duties under conditions of insufficient protection. With the recent developments of prolonged and intensive X-ray therapy the matter is also obviously



FIG. 103.—Section across tail of tadpole which died 27½ hours after irradiation. Showing hyperplasia and invasion of cerium by epithelial cells.



FIG. 104.—Section across tail of tadpole killed 48 hours after irradiation in protargol. General hyperplasia of epithelium is seen.

one of considerable importance, and accurate blood-counts are now a matter of routine procedure in the case both of workers and of patients undergoing treatment. A very large amount of work has been done upon the subject, which it is impossible to discuss here in full detail. The outstanding features

of exposure to the radiations are a marked diminution in the number of lymphocytes, together with a reduction in the number of red cells. In the earliest stages there may be a transient increase in both types of cell. Lymphocytes seem to be especially sensitive to radiations, exposures for quite short periods causing a marked diminution in the lymphocyte count. Polymorphonuclear leucocytes are also diminished in number, but not to the same extent as the lymphocytes. Blood-platelets as a consequence of exposure show a rapid diminution in numbers, followed by a rapid recovery.

As regards the action of radiations upon blood *in vitro*, exposure to radium emanation produces hæmolysis, with the formation of methæmoglobin, the  $\alpha$  particles taking by far the largest part in the production of the phenomenon, and they are also destructive to the opsonic power of the serum and to the hæmolytic complement. Exposure to X rays has not been found to interfere with the action of immune sera, nor with that of the hæmolytic complement. Further experimental work, however, is necessary upon the question of the action of radiations upon immune sera. Hæmolytic complement is notoriously unstable, but exposure of samples for two hours to X rays of moderate hardness was found to be without effect.

**Action on the Intestines.**—The mucous membrane of the intestine is extremely sensitive both to X rays and to the  $\gamma$  radiations from radium, a fact which must be borne in mind from the point of view of the protection of the X-ray worker and of the patient when radiations are being used for the treatment of abdominal conditions. The earliest effect of exposure is the production of an inflammatory condition associated with diarrhœa and, if the dose of rays has been sufficient, the passage of blood-stained mucus. More prolonged exposures lead to destruction of the lining epithelium of the gut, with shrivelling and atrophy of the subjacent tissue. The occurrence of diarrhœa, then, in the case of persons working with X rays or in that of patients undergoing X-ray treatment in the abdominal region, should always receive attention when there is no other obvious cause for its occurrence.

### CLINICAL INVESTIGATIONS.

The clinical material investigated was as follows: (1) *Carcinoma of the breast*, 25 cases; (2) *Rodent ulcer*, 58; (3) *Lymphosarcoma of neck*, 4; (4) *Sarcoma of femur*, 3; (5) *Carcinoma of lip*, 2; (6) *Carcinoma of thyroid*, 1; (7) *Carcinoma of mouth*, 4; (8) *Carcinoma of cervix uteri*, 3.

**1. Carcinoma of the Breast.**—The cases of carcinoma of the breast had had a complete amputation of the breast performed previously to the X-ray or radium treatment. No pre-operation treatment by irradiation was given, for the following reasons: the skin under such conditions heals badly, the risk of sepsis is increased, and the tissues are more congested, so that oozing is often considerable. Of the 25 cases, 15 received post-operative irradiation from X rays, this treatment only being given when there were signs of recurrence. All these cases died, the average period being three years from date of operation. Ten cases received immediate radium irradiation at the time of the operation, and subsequent X-ray treatment. Of these, 2 died from secondary manifestations after five and six years respectively. The remaining 8 are alive after an average of six years, although 3 have signs of internal metastases.

The outstanding fact in this series is that no local recurrences have been observed in the cases treated with radium at the time of the operation.

*Case 6* in this series was of interest in showing the effect of radiations on the blood-count.

*Case 6.*—Mrs. S. B., age 50, came under observation in May, 1921, with a lump in the upper and outer quadrant of the left breast. Patient stated she had noticed a lump for six months. The tumour was not attached to the skin or deep fascia. There were no palpable glands in the axilla. Radical removal of the breast, together with both pectoral muscles, axillary fat, and glands, was performed at the end of May. The wound healed well. The tumour was a spheroidal-celled carcinoma. When the patient was seen again early in September, 1921, there was a small recurrent nodule in the scar. It was decided to give X-ray treatment and to see what effect this had on the blood-count. A full pastille dose was given to four areas of the thorax through a 4-mm. aluminium filter, and a blood-count was taken again immediately after the X-ray treatment, and again on the two following days.

BLOOD-COUNT BEFORE X-RAY TREATMENT		AFTER X-RAY TREATMENT			
	Sept. 20, 1921	Sept. 20, 1921	Sept. 21, 1921	Sept. 22, 1921	
Red blood-corpuscles.					
per c.mm.	6,148,000	6,000,100	6,100,000	6,384,000	
Total leucocytes,					
per c.mm.	12,000	12,800	13,000	10,600	
Polynuclears	68.0 per cent	72.4 per cent	74.4 per cent	70.3 per cent	
Lymphocytes	29.4 "	26.0 "	24.0 "	27.6 "	
Eosinophils	7.0 "	1.6 "	1.6 "	2.1 "	

A few days afterwards, on Sept. 27, a blood-count was taken and the patient submitted to a pseudo-dose of X rays, the blood-count was taken, the patient was given a full pastille dose to four areas on the left side of the thorax, and the count taken again. This was tried in order to see if the pseudo X rays had any effects on the leucocyte-count. It was found that no difference could be made out. The results were as follows:—

BLOOD-COUNT BEFORE PSEUDO X RAYS		AFTER SAME		AFTER X RAYS	
Red blood-corpuscles	5,936,000				
Total leucocytes	10,400	10,800		9,000	
Polynuclears	74.2 per cent	72.6 per cent		73.3 per cent	
Lymphocytes	24.7 "	24.8 "		26.3 "	
Eosinophils	21.0 "	2.4 "		0.5 "	

Again, on Oct. 5, 1921, a blood-count was performed before and after the same dose of X rays.

BEFORE X RAYS		AFTER X RAYS	
Red blood-corpuscles	4,368,000		
Total leucocytes	11,500	10,400	
Lymphocytes	27.6 per cent	32.7 per cent	
Basophils	0.1 "	0.3 "	
Eosinophils	1.2 "	1.2 "	
Polynuclears	71.1 "	65.8 "	

At first X-ray treatment seems to have a stimulating effect on the production of leucocytes, and later on its action is inhibitory, so that it is necessary when giving deep X-ray therapy to have a blood examination performed from time to time.

In this case radium treatment was substituted in November, 1921, 60 mgrm. filtered through 2 mm. of lead being applied to the recurrent nodule for four hours each month. The nodule disappeared, but the patient gradually became more breathless in February, 1922, and died in the following May. A skiagram demonstrated large secondary deposits in the thorax. No post-mortem examination was permitted.

**2. Rodent Ulcer.**—In the treatment of the earlier cases of rodent ulcer, large doses of radium were used in combination with lead filters; very poor results were obtained. The ulcer increased in size, and in several cases excision was eventually performed. One of the most hopeful methods of application of radium appears to be that of repeated small doses daily for a period of seven to fourteen days, followed by a week or fortnight's rest, when the course of treatment is resumed. In these cases no screen was used beyond the platinum containers in which the radium was placed, which was separated



FIG. 105.—Photograph showing position of rodent ulcer before radium treatment.



FIG. 106.—Photograph showing condition of rodent ulcer after fifteen months' radium treatment.

from the diseased surface merely by a layer of guttapercha or lint, thereby allowing the passage not only of the softer  $\gamma$  radiations, but also some of the hard  $\beta$  rays which appear to play an important part in the process of treatment.

*Case 2* in this series is of interest because histological examination was carried out before and after radium treatment. It may be laid down as a general rule that if a rodent ulcer does not respond to radium or X-ray treatment after three months, it should be excised.

*Case 2 (Figs. 105-109).*—William P., age 66, first came under observation in September, 1920, complaining of a small ulcer the size of a shilling situated in the

right temporal region 2 in. behind and 3 in. above the external canthus (*Fig. 105*). This ulcer began in October, 1919, as a small pimple which slowly grew larger and broke down and was treated by different kinds of ointments which had no effect. A small piece of the edge of the ulcer was removed, and microscopically it proved to be a rodent ulcer (*Fig. 108*). Radium treatment was tried for fourteen months;



FIG. 107.—Photograph one month after excision and skin-grafting.

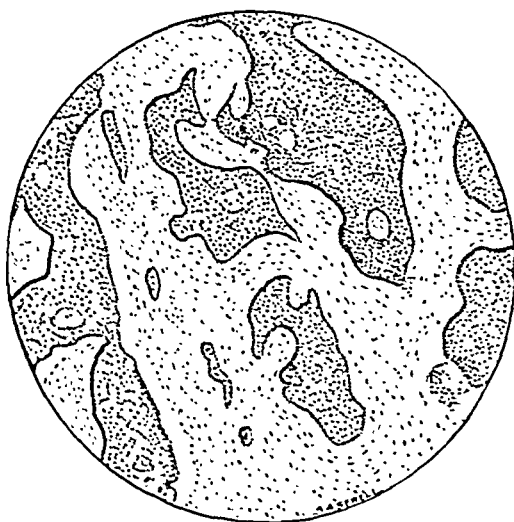


FIG. 108.—Section of edge of rodent ulcer excised before treatment.

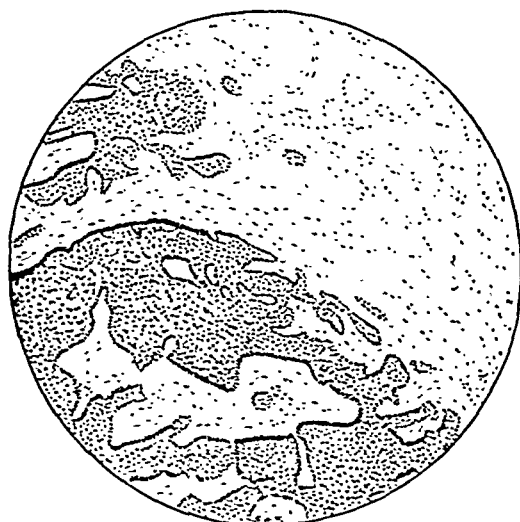


FIG. 109.—Section taken after excision of rodent ulcer, showing marked fibrosis as the only change consequent on radium treatment.

60 mgrm. of radium filtered through 2 mm. of platinum were applied to the ulcer every two weeks until December, 1921. As no improvement took place, the ulcer was completely excised and the bare area skin-grafted. The microscopical appearance of the ulcer after removal revealed the fact that a very definite fibrosis had taken place (*Fig. 109*).

3. **Lymphosarcoma of Neck.**—The four cases of lymphosarcoma all responded well locally to radium irradiation at first, but death occurred in each case owing to widely disseminated and deeply-seated metastases.

*Case 2 (Figs. 110–114).*—George W., age 66, came under observation in April, 1922, with a large tumour on the left side of his neck (*Fig. 110*). He first noticed a small lump behind his ear in February, 1922, which soon spread to the whole of



FIG. 110.—Photograph of patient with lymphosarcoma before radium treatment.



FIG. 111.—Photograph showing condition of patient five days after the insertion of 200 mgrm. of radium.



FIG. 112.—Photograph of same patient taken two months after *Fig. 111*.

the side of his neck. At the beginning of May, 1922, the swelling was so large that it compressed the trachea, and a tracheotomy had to be performed on May 10. Radium, 200 mgrm., filtered through 2 mm. of platinum, was inserted deeply into the tumour for eighteen hours on May 15. A small portion of the growth was removed for microscopical examination; the tumour proved to be a lymphosarcoma (*Fig. 113*). The tumour commenced to disappear on May 17, and had

become very much smaller by the 18th, and on May 20 a photograph was taken (*Fig. 111*); the tumour had almost completely disappeared. However, in July growth became palpable on the left side of the neck again, and 100 mgrm. of radium were inserted into the neck for twelve hours; in August, the same quantity of radium

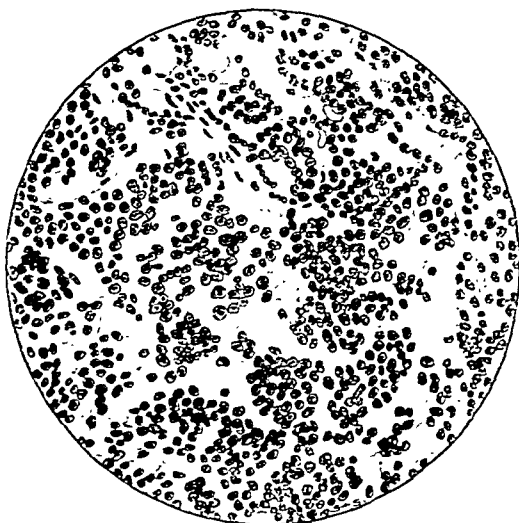


FIG. 113.—Section of lymphosarcoma from portion excised before commencement of radium treatment.

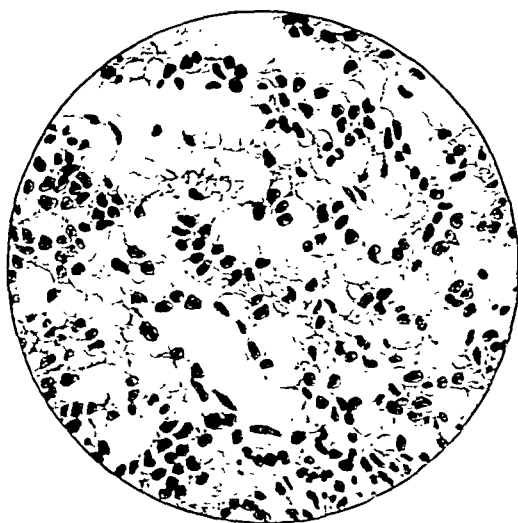


FIG. 114.—Section of growth removed post mortem six months after commencement of radium treatment: showing some degree of degeneration and slight fibrosis.

was again inserted for the same period. The growth had progressed (*Fig. 112*), and in September appeared on the right side of the neck. Radium was again applied, and a small piece of growth removed to ascertain what changes the radium had caused. *Fig. 114* is a microscope drawing of the tumour. The tumour grew steadily on both sides of the neck, and the patient died on Nov. 3, 1922.



4. **Sarcoma of Femur.**—The three cases of periosteal sarcoma of the femur were inoperable when they came under treatment; in each case secondary deposits were present in the lungs. The size of the primary growth diminished as a result of local insertion of radium combined with X-ray therapy. Death in all cases was due to pulmonary metastases.

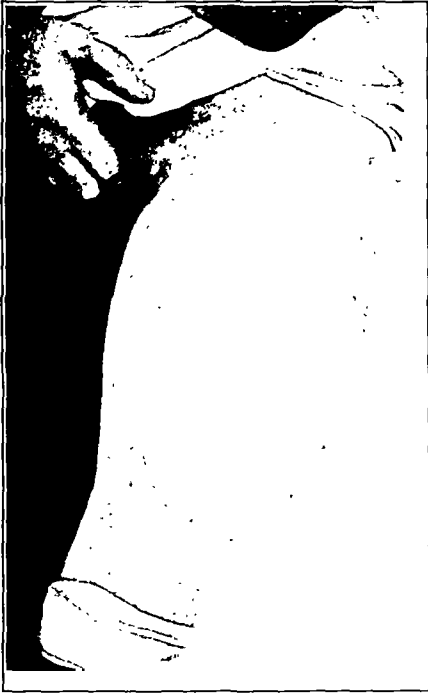


FIG. 115.—Photograph of periosteal sarcoma of femur before radium application.

discovered. Skin not discoloured; no solution of continuity; skin not adherent except for a small area posteriorly. The tumour was fixed to the femur. No egg-shell crackling. Slightly tender to touch. Knee fixed in slight flexion. Liver not palpable. Spleen not felt. No glands. Some dullness in both lungs behind, alongside vertebræ. Secondary deposits confirmed by X rays.

**OPERATION, March 17, 1921.**—A small incision was made in the anterolateral aspect of left thigh over the most prominent part of the tumour. A small piece of the tumour was removed. Macroscopically the tumour looked malignant, and there was no capsule over it. Through the incision 60 mgrm. of radium were inserted for twenty-four hours. The tumour proved on microscopic examination to be a spindle-celled sarcoma (Fig. 116). On March 25 a quantity of

*Case 1 (Figs. 115–118).*—William L., age 26, married, two children, was admitted to hospital on March 16, 1921, complaining of a tumour in the left thigh. He gave the following history: In August, 1915, while a soldier serving in France, he received a blow on the left thigh from a clod of earth due to the bursting of a shell. He was invalided home twelve months later with a wasted leg. He was admitted to several Army hospitals during the following year, and was finally discharged from the Army in September, 1917, with a pension. In the spring of 1918 he first noticed that his leg was swelling; this gradually increased till March, 1921, when patient, who had been working as a fitter's mate, had to give up work and was admitted to hospital. On examination a firm hard swelling of the left thigh was

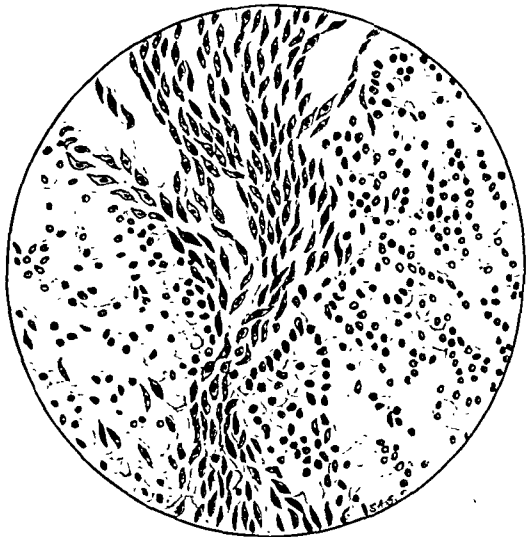


FIG. 116.—Section of periosteal sarcoma of femur before treatment.

radium emanation equal to 100 mgrm. of radium was inserted into the thigh for forty-eight hours. A blood-count was performed on April 9 :—

Red blood-corpuscles	6,320,000 per c.mm. (126.4 per cent)	Polynuclear leucocytes ..	80.4 per cent
Hæmoglobin .. ..	98 ..	Eosinophils .. ..	3.3 ..
Colour index .. ..	0.77 ..	Lymphocytes .. ..	15.6 ..
		Mast-cells .. ..	0.7 ..

On May 12, 1921, 60 mgrm. of radium with a 1-mm. filter of lead were inserted into a secondary growth in the right lung. The 7th rib was resected and the lung exposed under intratracheal ether anæsthesia. The radium was removed after forty-eight hours.

On May 19, 60 mgrm. of radium with a 1-mm. filter of lead were again inserted into the left thigh for forty-eight hours. The thigh measurement had gone down from 28 in. to 25 in., and patient had gained one stone in weight. Blood-count, May 27, 1921 :—

Red blood-corpuscles	4,068,000 per c.mm.	Polynuclear leucocytes ..	76.8 per cent
White blood-corpuscles	3,600 ..	Eosinophils .. ..	5.2 ..
Hæmoglobin .. ..	60 per cent	Lymphocytes .. ..	13.2 ..
		Mast-cells .. ..	3.8 ..

On June 3, 60 mgrm. of radium with a 1-mm. filter of lead were inserted into the left thigh for forty-eight hours, and again, on June 18, 60 mgrm. of radium with a 1-mm. filter of lead were inserted into the right thigh for forty-eight hours. On July 9, 60 mgrm. of radium with a 1-mm. filter of lead were inserted into a secondary deposit in the left lung under intratracheal anæsthesia, a portion of the 7th rib having been resected. The radium was removed after forty-eight hours. The patient began to lose weight and to go down-hill rapidly after the middle of July, and died on Aug. 1, 1921.

POST-MORTEM EXAMINATION.—Was performed on Aug. 2. The left thigh was amputated and sectioned (*see Figs. 117, 118*). It was a periosteal sarcoma of the spindle-celled variety. There were no growths in the liver or any other abdominal organs. The growths in both lungs were considerably smaller than at operation. There were some mediastinal glands affected with growth.



FIG. 117.—Photograph of femur and growth removed post mortem.

This man received during his stay in hospital the following X-ray treatment :—

March 19 : X-ray treatment to thigh—9 ports of entry 2 in. square : 6-mm. filter of aluminium ; one full pastille dose to each area : 62 pastille doses given to thigh between March 19 and May 10.

March 22 : Chest divided into 16 areas 2 in. square ; 6-mm. filter ; full pastille dose to each area ; two areas each day ; 88 pastille doses given to chest between March 22 and July 17.

**5. Carcinoma of Lip.**—The two cases of carcinoma of the lip were inoperable on account of secondary deposits in the glands of the neck which infiltrated deeper structures. Each case was remarkably unresponsive to radium treatment ; the needles of radium were buried in the growth in the usual manner.

**6. Carcinoma of Thyroid.**—The case of carcinoma of the thyroid, although

large doses of radium were inserted into the growth on several occasions, did not seem to be at all influenced, but the tumour gradually grew and caused the death of the patient within a year of the diagnosis being made.

**7. Carcinoma of Mouth.**

—The four cases of inoperable carcinoma of the floor of the mouth were quite unresponsive to radium treatment.

**8. Carcinoma of Cervix**

**Uteri.**—Of the three cases of carcinoma of the cervix, two died within nine months of the first insertion of radium ; whereas the other patient, though considered inoperable at the time radium was inserted.

was operated upon subsequently, and is still alive eighteen months after hysterectomy. The notes of this case are given below :—

Mrs. Ada G., age 58, came under observation in July, 1922, complaining of continuous slight hæmorrhage per vaginam. On examination the cervix was ulcerated and was fixed in position to surrounding structures. A diagnosis of inoperable carcinoma of the cervix was made. A small piece of tissue was removed from the cervix, and was found on microscopical examination to be malignant. Radium, 125 mgrm., with a 2-mm. platinum screen, were inserted into cervix for twenty-six hours. Two months later, on Sept. 15, patient was again examined under an anæsthetic. The cervix was now nearly flush with the vaginal vault and looked healthy. There was no sign of ulceration. In the right fornix only slight thickening could be felt ; whereas at the previous examination the pelvic cellular tissue appeared to be extremely involved and fixing the uterus, now the uterus was mobile in every direction. On Sept. 28, 1922, Wertheim's hysterectomy was performed ; the operation was quite easy.

On examination of the parts removed, the cervical canal presented what appeared to be a typical endocervical carcinomatous ulcer. This part was examined by the pathologist, who reported as follows : " Very little epithelium appears in any of the section ; such as there is shows no definite evidence of malignancy.

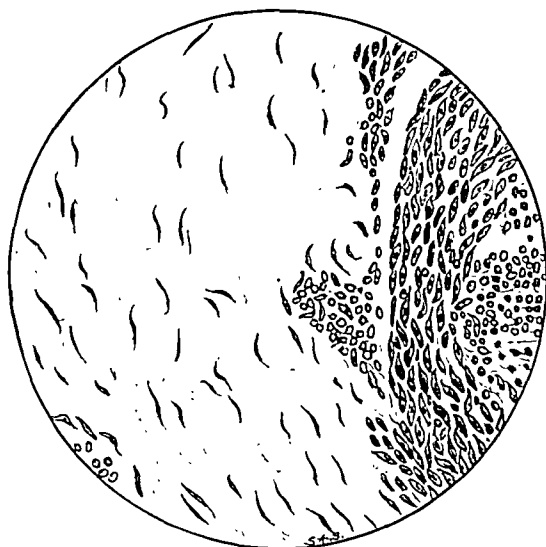


FIG. 118.—Section of growth showing marked fibrosis only after radium treatment.

"There are marked necrotic changes, hyaline degeneration, and fibrosis of the muscular coat."

The patient recovered well from the operation, and has put on half a stone in weight since leaving hospital.

### CONCLUSIONS.

As regards the mode of action of radiations upon living tissues, various views have from time to time been put forward, such as that the radiations decomposed the lecithin present in the tissue cells, and that its disintegration products acted in an ingenious manner. As a matter of fact this action upon lecithin has not been substantiated by subsequent research.

Another view is that of specific activation of intracellular enzymes. Here, again, most recent investigations fail to demonstrate any such action, and our experiments at King's College Hospital upon the oxidases laccase and tyrosinase fail to show any effect as to sequel to irradiation.

Probably no one theory can explain all the phenomena; but what does seem clearly established is that X rays and the  $\gamma$  radiations from radium have a marked effect upon certain classes of colloids, among which are proteins and starch. Proteins undergo a marked diminution in viscosity, and are more easily precipitable after a radiation than before. In the case of starch, as shown by Colwell and Russ<sup>6</sup> in 1912, this undergoes at any rate a partial change into soluble starch and dextrin.

It seems not improbable that certainly one of the effects of radiation is disturbance of the colloidal equilibrium of the cells, with consequent devitalization. If not carried too far the cell may recover, but if certain limits be exceeded the damage is irreparable, and the intracellular enzymes may then come into play, their action being of a destructive character upon the devitalized cell protoplasm.

The author wishes to acknowledge the kindly interest and assistance given him by his surgical colleagues, and by Dr. H. A. Colwell, Assistant Radiologist at King's College Hospital.

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**THE SURGICAL TREATMENT OF OSTEO-ARTHRITIS.**

*(Being the Hunterian Lecture delivered at the Royal College of Surgeons of England on February 6, 1924.)*

By C. MAX PAGE, LONDON.

THE chronic joint change recognized in England as osteo-arthritis, and on the Continent as arthritis deformans, is so general in its incidence that its milder forms may almost be regarded as a degenerative process associated with senescence. In certain cases, however, it assumes the character of a destructive pathological process, and may progress to such a degree as to produce serious disability, not only from pain, but on account of deformity secondary to absorption of bone. Moreover, the condition is by no means confined to those past middle age, and when it occurs early in life it seems to run an unusually active course.

The gross anatomy of the joint changes in osteo-arthritis has for long been clearly recognized, and industrious research has been carried out with a view to determining the cause of the condition. It must be admitted that though it has been demonstrated that the joint changes classified as osteo-arthritic may be initiated by several different factors, its etiology still remains obscure. The literature on the subject has become enriched with a confusing nomenclature which has developed as a result of the attempt to classify the various joint changes observed, generally on an anatomical basis. This aspect of the subject was very thoroughly reviewed here last year by Mr. Timbrell Fisher;<sup>1</sup> and at a discussion held at the Royal Society of Medicine<sup>2</sup> a few months later, what may be termed the medical side of the matter was fully debated.

I propose to devote my attention to a consideration of the treatment of cases in which the changes have so far progressed as to be beyond satisfactory relief by medical means. I shall simplify the subject further by omitting reference to conservative surgical methods, and shall confine myself strictly to a detailed consideration of the limited group of cases in which operative procedures can be held justifiable with a view to effecting a radical cure of the condition.

I do not wish to suggest that the more scientific, or even the empirical, procedures which have been applied to check the advance of the condition should be neglected as useless. There are two factors which are generally accepted as responsible for the progression, if not for the initiation, of this destructive process in a joint; they are (1) the presence of a chronic infective focus in some part of the body, and (2) strain or injury of the affected joint. Accepting these etiological causes, treatment directed to their elimination is a natural sequence. It is clear that the removal of any septic focus discovered in the body should not only be part of the treatment in early cases, but should receive equal attention in the more advanced instances in which operation is

contemplated. Rest of the joint involved is definitely suggested when there is pain.

How far the continuation of rest should be pursued with a view to obtaining an approximate cure by stabilization of the joint is an important question to decide, but one which it is difficult to answer. It is sometimes stated that rest and immobilization of an osteo-arthritic joint leads to its ankylosis. From my observation I doubt if a complete bony ankylosis ever results from the osteo-arthritic process unless a definitely inflammatory reaction is added to the ordinary picture. None the less, stability may be obtained by conservative treatment in an osteo-arthritic joint, at any rate sufficient to prevent the progressive absorption of bone, and to reduce the pain to an endurable degree. Once a joint has been denuded of its articular cartilage, progressive absorption will inevitably continue if any considerable range of movement is retained, and if it bears continuous weight. This point must be borne in mind when the selection of the type of operation best suited to the relief of the condition is made.

### THE SELECTION OF CASES SUITED TO OPERATIVE TREATMENT.

The primary indications for recourse to radical operation in an osteo-arthritic joint can, I think, be clearly defined as two in number, viz., (1) persistent pain, and (2) progressive deformity in relation to the joint affected. These indications hold good whatever anatomical form the disease assumes, and whether the principal causative factor appears to be trauma, bacterial infection, or toxic absorption. Operation will not usually be undertaken in the presence of evidence of active infection. In young people it may be employed to cut short the uncertain period (always a matter of years) in which stabilization of the joint may occur under non-operative treatment.

In practice the selection of cases for operation will be influenced by the number of joints involved, and the life expectation of the patient. In those cases in which one joint alone is seriously affected, and when there is no suggestion of a general infective process, the decision to operate is a straightforward one. When, on the other hand, the disease is polyarticular in its distribution, operation will only be undertaken to relieve intolerable pain, or to correct disabling deformity after the infective process has become quiescent.

Operations for intercurrent complications of an osteo-arthritic process in a joint, such as the removal of hypertrophic villi or loose bodies, are often resorted to, but they hardly come within the scope of this paper.

The procedures which have been put forward in order to deal radically with osteo-arthritic joints may be roughly classified under three headings, viz.: (1) *Excision of the joint*; (2) *Arthroplasty*; (3) *Erasion of the joint*; (4) *Synovectomy*. The aim of these operations in regard to the final function of the articulation varies considerably.

**1. Excision of the Joint.**—This is the oldest established procedure in the surgery of this condition.<sup>3, 4, 5</sup> Its primary aim is to relieve pain by the removal of the diseased joint surfaces. The functional result expected in the

cases of hip, elbow, wrist, and metatarsal phalangeal joint of the toe is a pseudo-arthritis. In the knee an arthrodesis in a good position is aimed at.

**2. Arthroplasty.**—The modern formal arthroplastic operation has not had an extensive trial in the treatment of osteo-arthritis, though it is favoured by some in the cases of the great-toe-joint. The operation is generally held to be an undesirable one for this condition, on account of the presumption that the new joint formed will undergo the same pathological changes as were responsible for the primary condition. Though there is evidence that this attitude is a reasonable one in the case of a weight-bearing joint, I do not think it need be adopted in respect of those articulations in which movement is only called for occasionally.

**3. Erasion.**—Erasion of a joint consists in removing the remaining articular cartilage and the underlying or exposed sclerosed bone, the general bony formation of the joint surfaces being retained. The final aim of this operation is generally to produce an arthrodesis, or at any rate fibrous ankylosis of the joint in a good position. In practice it will be found, as is shown in *Table I*, that in a fair number of cases this operation may leave a joint with quite a good range of movement.

**4. Synovectomy.**—This is essentially a conservative operation, which can only be expected to be successful in those cases in which little or no change has occurred in the articular cartilage; and it must therefore be undertaken at an early stage of the case. A radical synovectomy appears to have been first carried out by Müller<sup>6</sup> in 1894. He based it on the hypothesis that the destructive process in an osteo-arthritic joint was initiated in the synovial membrane. Few operations of this character have been recorded, and so the evidence of the truth of the theory is lacking. The class of case which appears to be satisfactorily dealt with by this means is that termed lipoma arborescens or hypertrophic villous synovitis. The condition is most commonly seen in the knee-joint, and from an examination of specimens the disease appears to be primarily synovial, gross deterioration in the articular cartilage only occurring in the later stage of the process.

The decision as to which of these operations should be employed, and also the nature of the after-treatment, varies considerably in respect of different joints; and I will now give some consideration to the more important individual instances.

### THE LOWER EXTREMITY.

**The Hip-joint.**—The pathological condition of the hip-joint associated with severe symptoms varies widely. The X-ray appearances always show reduction in the normal inter-articular space, on account of the absorption of articular cartilage; the degree of bone deformity may be slight or gross. This conforms to the rough division into atrophic and hypertrophic types. The atrophic form is most often seen in women and young adults, the hypertrophic being commoner in middle-aged and elderly men. A chronic arthritis initiated by a definite bacterial infection (e.g., the gonococcus or dysentery bacillus) will show approximately the same X-ray appearances as the atrophic type of osteo-arthritis. In those cases associated with old fractures of the

acetabulum, the appearances are influenced by the form of the primary injury. (*Figs. 119-122.*)

The choice of operation in this joint depends little, however, on the anatomical condition or etiology, but is determined by the age and general condition of the patient. In the young and middle-aged the aim should be not only to remove any pain but to provide a stable joint. This can be most effectually done by producing bony ankylosis at the joint line. An arthrodesis is most certainly produced by a complete erasion of the joint,



FIG. 119.—Hypertrophic osteo-arthritis of hip (*Case 31*).

followed by fixation in plaster-of-Paris in the position of election for a sufficient time to allow bony union to occur. This procedure was first advocated by Albee<sup>7</sup> in 1908. In his early series he merely rawed the upper surface of the femur and corresponding aspect of the acetabulum (*Fig. 123*). Latterly he has adopted a more thorough exposure of the joint, and further ensures bony ankylosis by the insertion of an autogenous bone graft.

The operation must be regarded as a severe one, though in my experience it is not associated with much shock. It is the prolonged after-fixation in



plaster-of-Paris in the recumbent position which is found most trying by the patient. The functional results of a fixed hip in a satisfactory position are remarkably good in the younger subjects. The most serious disability noticed as a rule by the patient is the difficulty he experiences in doing up his own boot on the side affected.

In reviewing the later results it is noticeable that elderly subjects sometimes develop pain in the lumbar spine and sacro-iliac joints after an arthrodesis of the hip. The fixation of the hip undoubtedly imposes a serious strain



FIG. 120.—Osteo-arthritis of hip with little bone change except at margins (*Case 4*).

on these joints. In elderly feeble patients an arthrodesis should not be attempted. A simple excision of the head of the femur has been most often favoured. Sir Robert Jones advises the production of a pseudo-arthritis at the base of the neck of the femur without touching the diseased joint. Both these latter operations relieve severe pain, but leave a joint of poor stability, and mean that the patient is left dependent on the use of crutches or a walking caliper.

Sampson Handley introduced the more conservative procedure to which

he gave the name cheilotomy, but there are few cases in which this operation could be expected to give a lasting cure. Platt advocates a partial excision of the head of the femur, leaving sufficient bone to engage the upper rim of the acetabulum. This leaves, in favourable cases, a stable joint with fair mobility.

In my own experience the operation of erosion of the joint has been well tolerated by old patients, and I have merely varied the after-treatment in their case by making no attempt at rigid fixation in plaster-of-Paris. A painless fibrous ankylosis or pseudo-arthritis is in this way obtained in a relatively short time; the hip is stable, but there is a tendency to the development of an adduction deformity.

The performance of a formal arthroplasty in the case of the hip-joint is a doubtful policy, and is hardly necessary in cases of osteo-arthritis. As stated above, a useful range of movement at the hip is obtained by an erosion of the joint followed by suitable after-treatment. Indeed, it is not easy to secure a sound bony ankylosis at the hip-joint, as is made clear by results seen in *Table I*. This experience falls in line with the frequency with which a pseudo-arthritis is formed after an unimpacted intracapsular fracture of the neck of the femur. This suppression of new bone-formation within the joint is due to the exposure of the broken surfaces to the influence of synovial fluid: the same condition prevails



FIG. 121.—Osteo-arthritis of hip with commencing dislocation (Case 28).

after an erosion or excision of the hip for a non-inflammatory condition.

In examining the later results (*Table I*) of cases of operation on the hip-joint, the tendency to the development of an adduction deformity is striking. This deformity results in serious functional shortening of the limb, from tilting of the pelvis when the erect attitude is assumed. As it is manifestly a complication to be avoided, it is worth while to examine the factors which are responsible for its production.

Adduction deformity is a notable feature in any case of destructive disease of the hip-joint. It appears to be due to at least two causes: (1) The proportionately excessive wasting of the gluteal muscles, which lie in intimate relation to the joint: the adductors, which are normally the master group,

are at a greater distance from the articulation and do not suffer so severely. (2) The abducting power of the glutei and tensor fasciæ femoris is reduced by the shortening of the lever (the neck of the femur) through which they act. Both these factors are operative in some degree after the operation



FIG. 122.—Traumatic arthritis of hip following an injury, presumably a fracture of the margin of the acetabulum (Case 18).

under consideration. Firstly, the muscles may be mechanically damaged or the nerve-supply interfered with if the incision is not carefully planned; secondly, any considerable removal of bone from the head of the femur, or unusual deepening of the acetabulum, will shorten the lever through which the muscles act.

The problem of avoiding the secondary development of adduction deformity after operation only arises when a fibrous joint is the result. If firm bony ankylosis is obtained in a good position by means of proper fixation, the difficulty does not arise; but it should be remembered that sound bony union is not always obtained, however carefully the operation may be carried out, and that union, apparently firm, if due to fibrous tissue, is liable to gradual stretching.

In all cases, therefore, of operations of this nature, the two simple mechanical factors above enunciated should receive attention, viz., (1) preservation of the full function of the gluteus medius and minimus and tensor fasciæ femoris, and (2) the preservation of the neck of the femur at as full length as possible. In practice, the adductors may be weakened by section of their tendons, followed by forced abduction of the thigh. To correct the result of shortening of the neck of the femur, Whitman<sup>8</sup> advocates the reimplantation of the bony insertion of the gluteus medius and minimus into the shaft of the femur a couple of inches below the normal position of the great trochanter. I have no experience of this procedure, but it seems to be based on sound lines.



FIG. 123.—Diagram of Albee's method of producing a bony ankylosis in the hip-joint (1912).

**The Knee.**—This joint, next to that of the big toe, is probably most commonly the site of serious osteo-arthritic change. It may be said at once that, as far as current general experience goes, a radical cure of osteo-arthritis of the knee can only be obtained with certainty by arthrodesing the joint. Such a final destructive procedure can only be justified in those cases in which pain is severe and persistent, or in which absorption of the bone of the outer condyles has deformed the joint. (*Fig. 121.*)

Many minor operative procedures, favoured by the size and accessibility of the joint, have had a fair trial. The removal of detached and sessile osteophytes, and the resection of enlarged processes of the synovial membrane, are often carried out for the relief of symptoms, though it is not expected that such operations will bring the morbid process to a standstill. The more radical procedure of complete synovectomy is a practical possibility in this joint, and can be applied to a limited number of cases.<sup>9</sup> When practised on those in which the chief and apparently primary change is in the synovial membrane, it has given satisfactory results.

I have found no records of a formal arthroplasty of the knee-joint in osteo-arthritis. Although the procedure cannot be regarded as likely to give a new joint permanently free from absorptive change, it should certainly be worth a trial in young patients. It is essentially conservative, and, if not successful, it should not prejudice the production of sound bony ankylosis at a second operation.

**The Ankle.**—Osteo-arthritic changes in the ankle are commonly originated by a trauma about the joint. It is not an uncommon sequence of infected compound fracture of the leg. The operative treatment of the condition has, in my experience, which has been limited to this type of case, been disappointing. Arthrodesis of the ankle-joint relieves the condition for a while, but is often followed after some months' use of the limb by the development of pain in the tarsal joints. The practice of arthrodesing the mid-tarsal joints at the same time as the ankle I have not found satisfactory. Pain in some part of the arch of the foot in front of the fixed joints commonly appears. I have actually carried out a Syme's amputation at the request of the patient in two cases a year or so after the complete arthrodesing operation had been done.

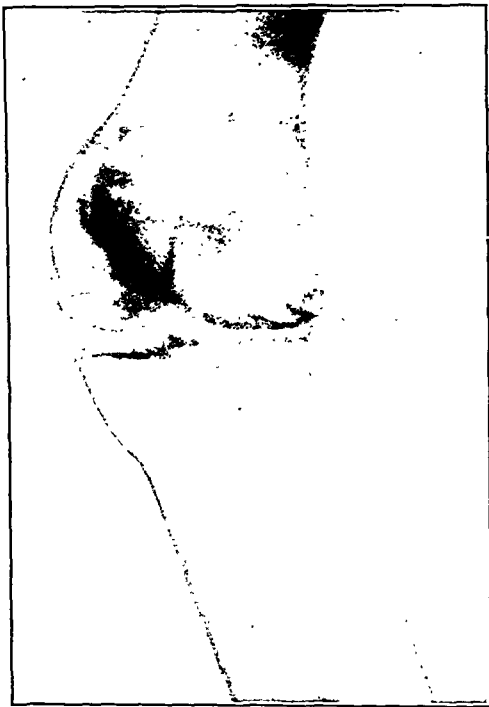


FIG. 121.—Severe osteo-arthritis of knee in a woman, age 47, with valgoid deformity.

A simple astragalectomy I do not think is much more satisfactory. The new joint between the tibia and the os calcis practically always becomes painful and develops arthritic changes. If resection of the astragalus is followed by the establishment of an arthrodesis between the tibia and upper surface of the os calcis with the foot dorsiflexed to 80 degrees, the functional results seem to be better.

My experience of the late results of operative treatment of osteo-arthritis in this joint seems to be at variance with some authors ; this is perhaps because it has been limited to cases in which widely diffused sepsis had been present at the inception of the condition.

**Tarsus.**—According to my observations the results of operation on the tarsal joints are not more satisfactory than those on the ankle. It seems that in the adult foot the removal of any substantial part of the bones of the tarsus imposes an irregular strain on the remaining joints, and seldom gives a good functional result. This is certainly true when the process has been associated with a pyogenic infection. In cases of simple fractures in civil practice where the arthritis is strictly confined initially to the injured joint, early operation may be more effective.

**Metatarsal Phalangeal Joint of the Big Toe.**—This joint is of interest in that it has furnished a mass of material from which one might expect to gather evidence of the value of operation on osteo-arthritic joints in general. The evidence, however, is not generally applicable, and certainly not in relation to weight-bearing joints. The operation undertaken has usually aimed at an arthroplasty. That generally practised takes the form of a free excision of the head of the metatarsal bone. Macausland and others practise a more conservative arthroplasty, inserting a fascial flap. In general the results of these excision operations is to leave a free or almost flail joint which cannot be subjected to much strain.

A careful examination of the late end-results of these cases is certainly needed before a final opinion can be formed on the true worth of the several methods advocated.

### THE UPPER EXTREMITY.

The joints of the upper extremity, though often enough the site of an osteo-arthritic change, will less often warrant radical operation than is the case in the lower limb. The disease does not tend to progress so far as in the lower extremity, because the joints do not bear weight and can be spared a good deal of their usual share of work without completely disabling the patient. A certain number of severe monarticular instances of the disease are, however, met with ; they are generally secondary to trauma. If the condition occurs in working men, operation is the only measure which will restore them to full industrial efficiency.

**Acromioclavicular Joint.**—Osteo-arthritis of this joint may produce a chronic disability generally recognized as a 'painful shoulder'. The excision of the joint is a minor operation which can easily be carried out, and it gives most satisfactory results if the cause of the pain has been correctly located.

**The Shoulder.**—The accurate diagnosis of the cause of chronic pain about the shoulder is by no means easy. Exploratory operation may be necessary to

establish it. From my limited experience of the operative treatment of osteo-arthritic conditions in this joint, I should say that, though gross bony deformity of the articular surfaces is uncommon, the minor operations undertaken for the removal of enlarged bursæ, etc., seldom give permanent relief. If radical operation is felt to be justifiable, an arthrodesis of the joint, with the humerus abducted 45 degrees from the normal and externally rotated and anteverted, probably gives the best functional result: the scapular movements being sufficient to secure a useful control of the position of the arm. A simple conservative resection of the head of the humerus is a better procedure if for any reason the movements of the scapula are restricted; or in elderly patients in whom the prolonged fixation which an arthrodesis requires is undesirable.

**The Elbow.**—Cases submitted to operation will usually be secondary to injury, and undertaken in the working period of the patient's life. The decision between an arthroplasty and an arthrodesis will be based on social grounds. An arthrodesis between the elbow and humerus with the elbow set at an angle of about 130 degrees gives a very useful arm for a worker, provided that the head of the radius is freely excised, so that the

movements at the radio-ulnar joints are maintained. An arthroplasty is better suited to women, and to men whose occupation is of a sedentary character.

**The Wrist and Carpal Joints.**—Osteo-arthritis of these joints is most often seen as the late sequel of carpal injuries. Operation will be undertaken for persistent pain rather than for limitation of movement. In my experience of some eight cases, excision of the proximal row of carpal bones, though very

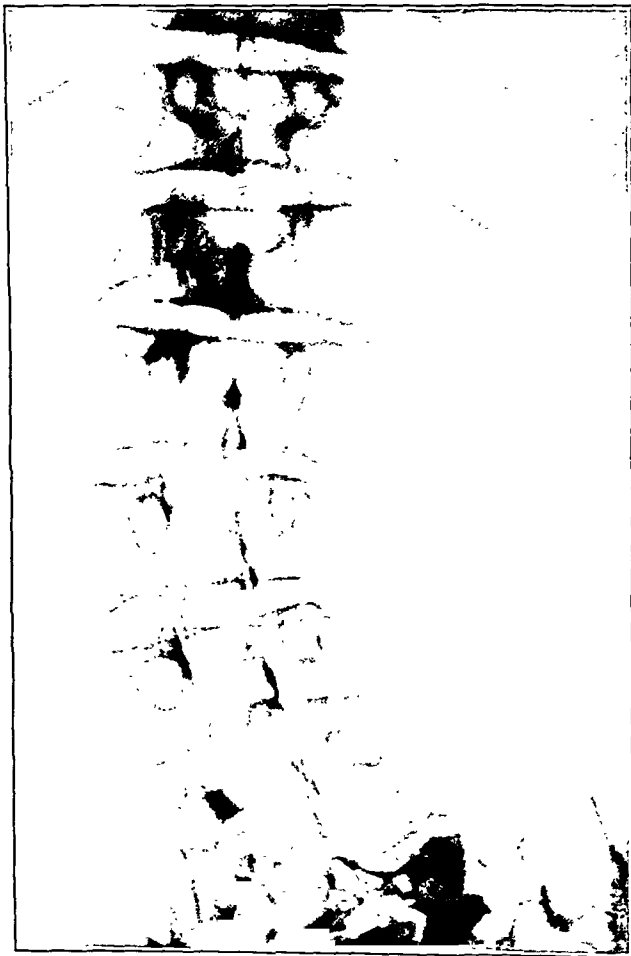


FIG. 125.—Traumatic spondylitis in a man, age 33.

often satisfactory in its immediate results, is disappointing later, a recurrence of the symptoms being common. A complete excision of the carpus is advocated by Vallas<sup>20</sup> for this condition. My experience of this somewhat drastic procedure is limited to two cases, and the final results showed little improvement on the primary condition.

In a working man the disablement is a serious one, and the poor results obtained by operation once the osteo-arthritic process is established enforces the importance of the careful early handling of cases of carpal injury.

**Temporomaxillary Joint.**—A disabling arthritis of this joint is most often met with in women. An excision of the condyle relieves the pain and leaves a useful joint. A shortcoming of the procedure is the slight deviation of the lower jaw towards the operated side which is involved.

**The Spine.**—The types of chronic change which can be recognized from the X-ray appearances can be roughly divided into two groups, viz. : (1) Those in which the bony changes are most in evidence, absorption of the bodies and marginal lipping being present (*Fig. 125*); (2) Those cases in which



FIG. 126.—Spondylitis deformans in a man, age 36, showing ossification of intervertebral ligaments and little other change.

ossification of the intervertebral ligaments is the prominent feature (*Fig. 126*).

In the latter type the serious clinical symptom is fixation of the spine due to bony deposit in the ligamentous structures. This is not subject to surgical control, and treatment must therefore be limited to prevention of deformity while the process is active, and to the securing of ankylosis in

an erect posture. The condition occurs in what is termed the Marie-Strümpell type of arthritis, and is often associated with involvement of the large joints of the extremities.

In the first-mentioned condition, which is more properly classified as one of osteo-arthritis and is generally termed traumatic spondylitis, the progressive absorption of bone may lead to severe pain from pressure on the emerging nerve roots. In such cases the possibilities of ankylosing the spinal processes by means of Albee's or Hibbs' method is worth considering in selected cases. I have undertaken two operations of this kind, but at too recent a date to be able to form any opinion as to the value of the final result. If operation is carried out for this condition, it appears to me to be difficult to determine what extent of the spine should be fixed. I attempted to arthrodesis the whole of the lumbar spine in both cases referred to.

**Sacro-iliac Joints.**—Some prominence has lately been given to the pain arising in these joints, and it has been termed sacro-iliac strain. In a great number of instances the condition appears to be due to an active osteo-arthritis of the joint. When the obstinacy of the case justifies it, an arthrodesis would appear to be the best method of operative treatment, and this has been carried out by bone-grafting in a plane posterior to the actual joint. I have no personal experience of the results of the procedure.

### TECHNIQUE OF OPERATION ON THE HIP-JOINT.

A good exposure of the hip-joint is not very readily obtained in a stout adult, and for any operation aiming at an erosion of the joint a good field of view is most important. The surgical approaches to the joint have been subject to a good deal of study,<sup>11</sup> and I propose only to outline those methods of which I have personal experience, and to examine the relative merits in relation to the subject under discussion.

In 35 consecutive operations carried out for chronic arthritis I have employed three routes, the posterior, the superolateral, and the supero-anterior.

**The Posterior Incision** (*Fig. 127*).—An oblique skin incision about 8 inches in length is made, starting at a point over the posterior inferior iliac spine, and extending forwards and downwards, terminating just external to the anterior margin of the great trochanter of the femur. The underlying gluteus maximus is split in the length of the incision; the sections are then retracted upwards and downwards to expose the posterior and upper aspect of the capsule of the hip-joint. The view is somewhat obscured by the pyriformis and gemelli. These may have to be divided to gain access to the joint, but retraction is often sufficient. This incision does not give a good field of view, and it may be difficult to recognize the exact position of the joint margin. Dislocation of the head of the femur cannot be effected with ease or certainty. I have employed

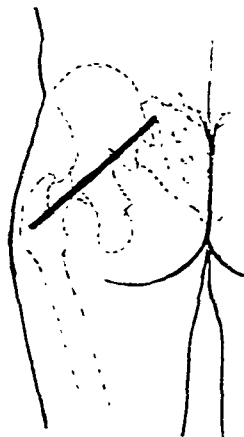


FIG. 127.—Diagram of skin incision: posterior approach.



this incision in five cases, but have given it up on the grounds stated above.

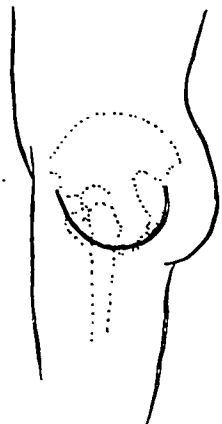


FIG. 128.—Diagram of skin incision: supero-external approach.

**The Supero-external Route** (*Fig. 128*).—This is based on that described by Murphy in his operation for arthroplasty of the hip, and also by Lexer. A skin flap is turned up representing a third of a circle: the anterior termination of the arc is brought over the anterior inferior spine, and the posterior lies in a similar relation to the posterior inferior spine. The flap is turned up on its base (*Fig. 129*); the underlying aponeurotic tendon of the gluteus maximus is divided in line with the anterior margin of the great trochanter. The tendinous flap is retracted backwards, exposing the great trochanter. This process of the femur is then cut through obliquely  $\frac{3}{4}$  in. from its upper margin with a wide thin-bladed osteotome. The detached fragment of bone is drawn upwards with a sharp hook, and with it the insertions of the gluteus medius and minimus, pyramidalis, and gemelli; the anterior margin of the gluteus

medius is dissected away from the posterior aspect of the tensor fasciæ femoris in order to free the flap. A good exposure of the upper and posterior surface of the joint is so obtained; the joint line can be clearly recognized by a rotation of the thigh (*Fig. 130*). The capsule of the joint is incised from above downwards and backwards. The head of the femur can then be dislocated backwards by an assistant. The knee is bent to a right angle and the thigh partially inverted in order to effect this. Access to the acetabulum is obtained by a suitable manipulation of the position of the head of the femur. The joint surfaces of the head of the femur and acetabulum can then be cut away with a broad gouge. The head of the femur is dropped back into place, and the great trochanter and the overlying aponeurosis are then re-sutured in place. I have used strong catgut for the purpose, and have always secured bony union of the trochanter and shaft.

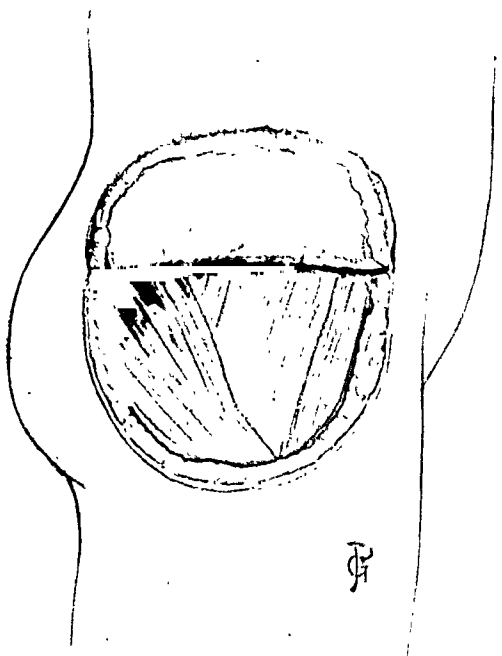


FIG. 129.—Diagram of area exposed by the skin flap in supero-external approach.

This route gives a good exposure of the joint, though in cases in which there has been gross deformation of the head of the femur complete dislocation may be found difficult or even impossible. The operation involves no division of blood-vessels of any size, and is absolutely conservative in regard to muscle function. I have used the method in twenty cases, and consider it certainly the most satisfactory for old patients on account of the rapidity with which it can be carried out and the small amount of muscle section which is necessary.

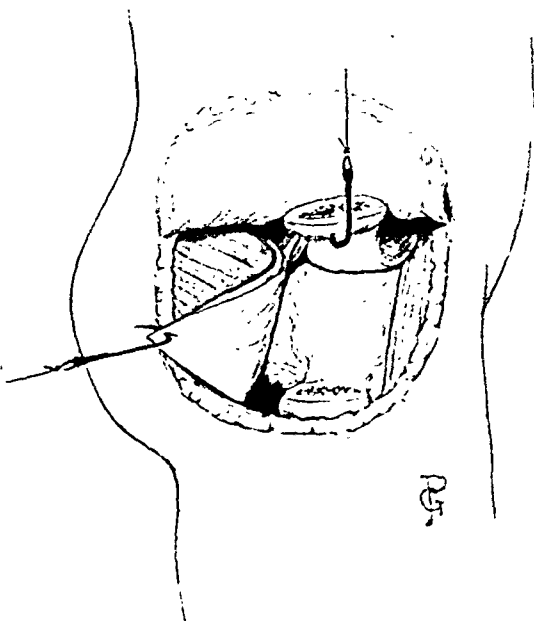


FIG. 130.—Supero-external approach: exposure completed.

incision directly downwards for about 5 inches. This vertical part of the incision lies over the border of the anterior portion of the tensor fasciæ femoris. The muscles are divided in the line of the skin incision; in the upper sector the origins of the gluteus medius and the tensor fasciæ femoris are cut through half an inch below the iliac crest (Fig. 132). In the vertical sector the fascia lata is divided at the anterior border of the tensor fasciæ femoris. The muscle flap so outlined is then separated from the underlying tissues, the gluteus medius being raised from the outer aspect of the venter of the ilium together with the underlying gluteus minimus. This exposes freely the front and upper aspect of the hip-joint, the reflected head of the rectus femoris lying immediately above it. In order to dislocate the head of the femur, the front part of the capsule must be incised and the outer border of the

### The Supero-anterior Approach.

—This route was introduced in the early part of the century by Sprengel in Germany and by Anderson in England for operations on tuberculous disease of the hip-joint. The method was again described in detail by Smith-Petersen<sup>12</sup> in 1912.

The skin incision (Fig. 131) is angulated, and consists of an upper curved section about 4 inches in length, parallel to and just below the anterior half of the iliac crest, and a vertical cut made from the anterior extremity of this

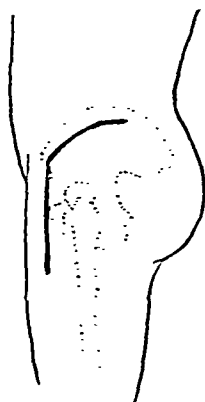


FIG. 131.—Diagram of skin incision: supero-anterior approach.

iliofemoral ligament divided. Dislocation is effected by an assistant strongly everting the thigh, after the latter has been flexed to a right angle.

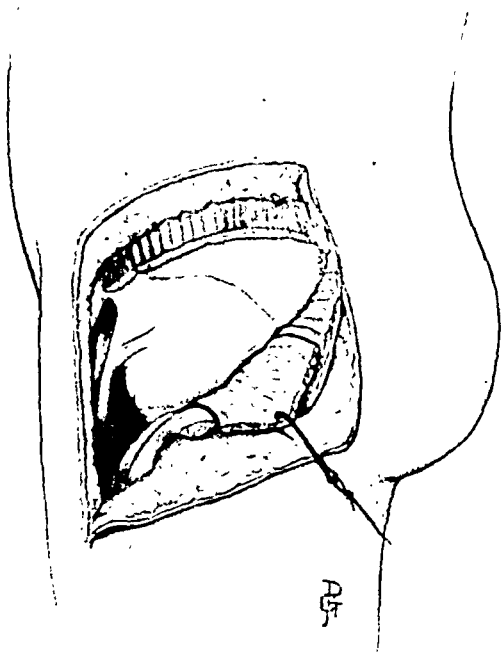


FIG. 132.—Supero-anterior approach: the muscle flap turned down.

This incision gives the fullest exposure of the joint, and renders the accurate recognition of the bony parts very easy. In children the gluteal flap can be raised subperiosteally, but in the adult this is not possible, and the separation of these muscles from the bone involves a good deal of minor bleeding. If the head of the femur is dislocated through this approach in order to effect a complete erosion of the joint, it should be noted that the iliofemoral ligament must be damaged; though this is of no importance if bony ankylosis is secured, it is not desirable if a movable joint results. The intact ligament is also, I think, of some importance in the maintenance of close bony contact of the rawed surfaces after operation. I have used the incision in nine cases, and, owing to the reasons stated, I am inclined to consider it not as satisfactory as the supero-external route.

### TECHNIQUE OF OPERATION ON THE KNEE.

**Excision of the Knee (Figs. 133–136).**—When undertaken in osteoarthritis the aim of this operation is the production of sound bony ankylosis in a slightly flexed position. Classical methods, though usually successful in securing this result, occasionally fail, and union is established by fibrous tissue. The factors which may lead to union of this character appear to be three, viz., (1) sclerosis of the bone surfaces apposed, (2) lack of close contact between the prepared surfaces, and (3) the access of synovial fluid to the cut bone. The incidence of these factors can be prevented by attention to the following details: (1) The synovial pouch should be dissected out, the bulk of the synovial tissue in the joint being in this way removed; (2) The section of bone should be so planned that vascular cancellous bone is exposed everywhere except at the margins; (3) I have usually assured close apposition of the cut bone surfaces, without any special splinting, by pulling the patella down to the level of the tibia and pegging it in position there. The articular cartilage of the patella is previously cut off. The bone is most effectively



FIG. 135.—Side view of excised knee, Fixation secured by the use of beef-bone pegs.

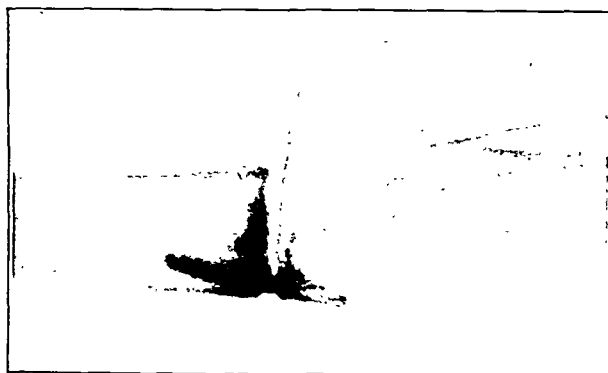


FIG. 134.—Side view of knee shown in Fig. 133, after an autogenous key graft had been inserted to secure bony union; X-ray three months after second operation.

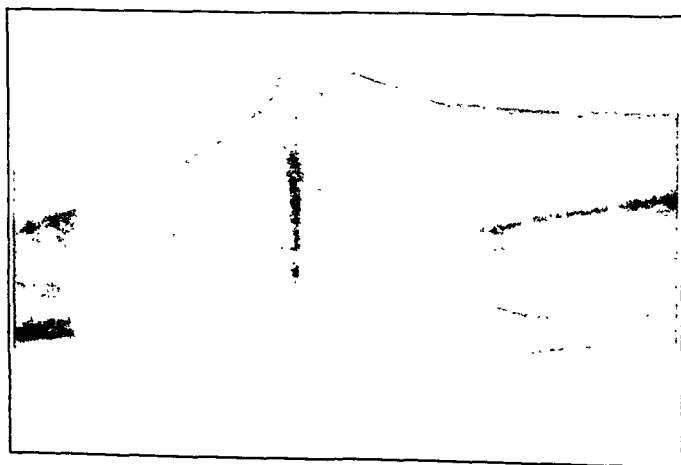


FIG. 133.—Fibrous union present in a knee excised two years previously. Male, age 42.

held by means of a long French nail. This procedure holds the bone surfaces firmly in contact by the tonic pull of the quadriceps muscle and its opponents. The method has the practical advantage that the cut surfaces are



FIG. 136.—Excision of knee fixed by nailing patella to tibia.

so firmly held in position that it is unnecessary to use plaster for fixation of the limb after the operation, a simple gutter excision splint being applied. A close-fitting plaster case can be fitted in a week or so after the skin stitches have been removed.

The only drawback to this method is that the pull of the quadriceps may be sufficiently strong to angulate the joint forwards, opening up the posterior aspect of the cut surfaces. This tendency can be controlled without difficulty when the plaster case is applied. This form of the operation can be carried out if the usual U flap of skin be turned up, but I think an H-shape incision is better. It gives full access to the operation area without involving the risk of marginal sloughing of the skin flap.

### AFTER-TREATMENT.

**Hip-joint.**—The form of the after-treatment adopted is determined according to whether bony ankylosis is desired, or whether fibrous union at the joint is deemed sufficient. In young healthy subjects the satisfactory final results of an arthrodesis will settle the question. In elderly or feeble patients a fibrous joint will be accepted in order to minimize the discomforts of after-treatment.

In order to obtain bony union, I think satisfactory fixation in plaster-of-Paris is essential. A single spica extending from below the ribs to the foot is applied immediately after operation. The thigh is set in the position of election, viz., slight abduction, 20 degrees of flexion, with the foot slightly everted. The first plaster is changed in about a fortnight, when the wound stitches can be removed, and another is applied. The second plaster must control the abduction, and if this cannot be done by moulding the plaster on the pelvis, coupled with an extension to the axilla on the opposite side to the injury, the sound leg should be included. At six or eight weeks after operation the plaster is cut away in order to free the knee-joint. At eight to twelve weeks the patient can get about with crutches, retaining a short spica for another month. Weight-bearing is allowed during this period. At

three to four months after operation the plaster is removed and the condition of the joint examined radiologically; if union is firm, the patient can be allowed to walk with sticks. Full return of function cannot be expected under six months from operation, and may be deferred for twelve.

The ideal position for fixation of the hip varies somewhat in relation to the occupation of the patient. Flexion beyond 20 degrees involves considerable compensatory lordosis of the lumbar spine when the erect position is adopted. For this reason flexion in an outdoor labourer should not exceed that degree. In cases in which the patient wants to be able to drive a car of standard proportions, flexion to 30 degrees must be given unless the man is very short. *Case 20* is a good example of the functional result obtained in such cases; twelve months after operation he was able to pass the police taxi test, and now drives a cab daily.

Some fixation of the knee commonly follows the prolonged immobilization in plaster, but it is only likely to be permanent in elderly patients, the full range being restored on the average after a few weeks' physical treatment.

When the aim is fibrous union, after operation the limb is slung in a Hodgen's or similar splint and a light extension applied. The position maintained should approximately be that of election already described. The extension is removed at the end of three or four weeks, and the patient allowed to get up on crutches swinging the damaged leg. Weight-bearing is not encouraged till six weeks after operation. Though the period during which the patient is confined to bed is reduced, the final return of function is usually less rapid and less satisfactory than when an ankylosis is obtained.

**The Knee-joint.**—When the knee has been excised by the method described above, a simple metal gutter splint is applied, extending from the tuber to the lower part of the calf, for a couple of weeks. It is then replaced by a close-fitting plaster cast extending from the tuber to the malleolus. The patient gets up in from four to six weeks after operation, and walks with crutches for a month or so, gradually putting more weight through the joint. Union is generally firm in from three to four months.

### LATE RESULTS OF OPERATION.

**The Hip-joint.**—In the estimate of the final results of these operations on the hip the views of the patient and surgeon are somewhat different. The former is well satisfied if he loses his pain and is left with a limb whose functional value is not worse than before operation. The surgeon, on the other hand, recognizes that the removal of the pain is readily effected, and looks rather for an improvement in the functional value of the limb. In either case the true merit of the procedure can only be fairly assessed by a study of the results some years after operation. This particularly applies if operation is undertaken during the active period of the patient's life, when the resulting function of the limb is almost as important as the relief of pain.

The evidence in the literature on the subject is somewhat meagre, only a few authors having published the details of the late results of any considerable number of cases. The outcome of operations aiming at arthrodesis have received the most attention.

Table I.—34 CASES OF OSTEO-AR

NO.	NAME	AGE AND SEX	SIDE	DATE OF OPERATION	CONDITION AND ETIOLOGY	OPERATION	APPROACH	DATE OBSERVED
1	Pens. S.	32 M.	R.	1.12.19	2 years treated as tuberculous hip. X-ray and histological examination showed chronic arthritis	Partial erosion. Head not dislocated. Fixed in plaster 2 months	Supero-anterior	1.2.21
2	F. F.	69 M.	R.	5.2.20	8 years progressive hypertrophic osteo-arthritis. Partial dislocation. Adduction and flexion +. Muscle spasm +	Partial erosion. Head not dislocated. Poorly fixed in plaster 6 weeks	Posterior	6.7.22
3	K. H.	43 F.	R.	6.3.20	3 years increasing pain and stiffness. Osteo-arthritis	Partial erosion. Head not dislocated. Fixed in plaster 2 months	Posterior	30.1.21
4	A. K.	60 M.	L.	4.4.20	10 years pain and stiffness. Hip flexed and adducted. Hypertrophic osteo-arthritis	Erosion of joint. Tenotomy of adductors. In plaster 2 months	Supero-lateral	10.1.21
5	Pens. E.	34 M.	L.	17.5.20	Fell from lorry 18 months before. X-ray: no fracture. Traumatic arthritis	Complete erosion of joint after dislocation. In plaster 2½ months	Supero-lateral	3.4.22
6	E. D.	48 F.	L.	29.5.20	4 years pain. Osteo-arthritis	Partial erosion. In plaster 6 weeks	Posterior	16.1.24
7	Pens. P.	42 M.	L.	3.8.20	2 years ago fractured neck of femur. Painful false joint	Excision of head of femur. Arthrodesis attempted by bone peg and fixation in plaster	Supero-lateral	1.2.23
8	W. S.	45 M.	L.	20.11.20	2 years ago fractured neck of femur. Union in bad position. Secondary arthritis	Partial excision of head. Fixation in plaster	Supero-lateral	10.1.24
9	Pens. F.	24 M.	R.	1.1.21	Ununited fractured neck of femur complicating paraplegia of obscure origin (? acute myelitis) 2 years. Hip flexed and adducted	Excision of head. Arthrodesis of neck without bone peg. In plaster 2 months	Supero-lateral	4.6.22
10	S. B.	55 F.	L.	16.1.21	Osteo-arthritis, monarticular. 5 years increasing pain. Spasm +	Erosion of joint after dislocation	Supero-lateral	4.1.24
11	Pens. W.	38 M.	L.	4.4.21	2 years pain in hip. ? Psoas abscess, suspected of T.B. X-ray and microscopic: osteo-arthritis	Erosion of joint. Head dislocated	Supero-lateral	4.4.21

# SURGICAL TREATMENT OF OSTEO-ARTHRITIS 171

## JOINT TREATED BY OPERATION.

PAIN IN HIP	PAIN IN OTHER JOINTS	FUNCTIONAL SHORTENING	FUNCTIONAL VALUE	REMARKS
None	—	$\frac{1}{2}$ inch	Good. Working as a carter in 1922, full day, continues to do so	Walked with sticks 10 weeks after operation. Finds sitting awkward on account of absence of flexion at hip
None	—	4 inches	Fair. Can stand about without discomfort. Walks with stick	Patient had become addicted to morphia before operation on account of pain. There was much spasm of the hamstrings, which made fixation in plaster splint difficult
None	—	1 $\frac{1}{2}$ inches	Can do all housework. Fair	Pyorrhœa +. Knee remained stiff after operation for some months. Did not walk without crutches for 4 months. Now occasional pain and stiffness in R. knee
None	—	2 inches	Fair, but unable to resume old work as carter	
None	—	None	Very good	Returned to work, but committed suicide in 1922, said to be due to family worries
None	—	1 inch	Can walk about 2 miles in comfort	Patient was very stout and was difficult to fix in plaster. Very slow in recovering general ambulatory function (5 months)
Occasional	—	3 inches	Poor. Walks fairly in caliper	Arthrodesis failed in this case
None. Pain in L. groin after long day	—	3 inches	Good. Does full day's work as gardener	Original aim at procuring an arthrodesis failed. Present joint seems useful, but X-ray suggests progressive absorption of bone
None	Nil	2 inches	Incomplete recovery of paraplegia. Could walk 6 months after operation	Final result not observed
None	None except for occasional stiffness in R. hip	1 $\frac{1}{2}$ inches	Can walk 2 miles on end and stand any length of time	Patient was of stout build and difficult to control in plaster
None	Some pain in L. knee and back	1 inch	Good	Patient of poor physique and lacking in enterprise: has not yet returned to work. Pain in back probably secondary to too great flexion of hip-joint

Continued on next page



Table I.—34 CASES OF OS

NO.	NAME	AGE AND SEX	SIDE	DATE OF OPERATION	CONDITION AND ETIOLOGY	OPERATION	APPROACH	LATEST DATE OBSERVED
12	Pens. C.	43 M.	L.	8.5.21	Dysentery 1916, followed by arthritis of spine and hips. Painful partial ankylosis of both hips	Erision of joint after dislocation	Supero-lateral	27.1.24
13	W.W.	60 M.	L.	3.6.21	Progressive hypertrophic osteo-arthritis	Erision of joint after dislocation. Fixed in plaster 2 months	Supero-lateral	4.7.23
14	Pens. D.	34 M.	R.	20.8.21	Osteo-arthritis. Few years increasing pain and stiffness	Partial erision, dislocation not possible	Supero-anterior	3.4.23
15	Pens. Gil.	37 M.	R.	20.10.21	Traumatic arthritis following gunshot wound of hip, non-suppurative	Excision of remains of head of femur. Arthrodesis with beef peg	Supero-lateral	4.11.23
16	Pens. Greg.	34 M.	L.	7.11.21	Traumatic arthritis following gunshot wound. Painful hip fixed by spasm	Excision of head. Arthrodesis with beef peg	Supero-lateral	10.12.23
17	L. L.	51 F.	L.	24.1.22	Osteo-arthritis of hip 3 years. Early osteo-arthritis of both knees	Erision of joint after dislocation of head. In plaster 2 months	Supero-lateral	7.9.23
18	Pens. M.	30 M.	L.	9.2.22	Traumatic osteo-arthritis. Hip stiff 4 years following an injury	Partial erision of joint. Dislocation not complete. Plaster 2 months	Supero-anterior	1.2.24
19	J. E.	51 M.	L.	16.2.22	Osteo-arthritis. Wearing caliper splint 18 months	Erision of joint after dislocation. Plaster fixation	Supero-lateral	7.1.24
20	R. L.	52 M.	L.	25.4.22	Hypertrophic osteo-arthritis 5 years	Erision of joint after dislocation. Plaster 7 weeks	Supero-lateral	25.1.24
21	Pens. N.	43 M.	L.	19.5.22	Arthritis of hip following enteric in 1919. X-ray appearances: osteo-arthritis	Erision of joint without complete dislocation	Supero-lateral	1.2.24
22	W.W.	66 M.	L.	6.6.22	Hypertrophic osteo-arthritis 5 years	Erision of joint after dislocation. Fixed in plaster 6 weeks	Supero-lateral	9.11.22
23	H. B.	59 M.	L.	20.6.22	Hypertrophic osteo-arthritis 2 years	Erision of joint after dislocation. In plaster 2 months	Supero-lateral	10.10.23

# SURGICAL TREATMENT OF OSTEO-ARTHRITIS 173

## TREATED BY OPERATION—continued.

PAIN IN HIP	PAIN IN OTHER JOINTS	FUNCTIONAL SHORTENING	FUNCTIONAL VALUE	REMARKS
None	Occasional in back	—	Can walk a few hundred yards	Arthroplasty of R. hip 5.3.21. Spine is stiff and kyphotic
None	L. knee occasional	1½ inches	Fair	Had not returned to his work as engine-driver in July, 1923
None	None	1 inch	Good	Returned to work as barman 7.7.22
None	None	2 inches	Good	Returned to work as upholsterer
None	Slight in lumbar spine	2½ inches	Good	Walked without stick 5 months after operation
Occasional in L. groin	In L. knee and both sacro-iliac areas	1½ inches	Poor 1½ years after operation. Could walk a mile or two	Swelling of whole 2 weeks after operation. No infection. Swelling gradually settled down, but L. knee somewhat stiff. Sacro-iliac pain was relieved in some measure by a Goldthwaite belt. Poor-hearted patient.
None, or slight in groin and thigh	None	None	Good. Works daily as milkman	Complained of awkwardness in sitting down due to slight degree of flexion of hip
None	Occasional in L. knee	1½ inches	Good. Can walk 'any' distance	Returned to work as barman
None	None	1½ inches	Good	In 1923, passed Metropolitan Police examination as taxi-driver, and now working as such. Unusual flexion of hip given on account of occupation.
Slight after heavy work in wet weather	None	1 inch	Good	Working as liftman
None	None	1 inch	Walking with sticks	Died. March, 1923: said to be from pneumonia
Some in groin	L. knee stiff and painful	2 inches	Poor. Could walk about a mile with a stick	Developed swelling in both legs 6 months after operation. Possibly due to venous thrombosis. Under medical treatment for emphysema and myocarditis

*Continued on next page*

Table I.—34 CASES OF OSTEO-AR.

NO.	NAME	AGE AND SEX	SIDE	DATE OF OPERATION	CONDITION AND ETIOLOGY	OPERATION	APPROACH	LATEST DATE OBSERVED
24	F. T.	37 F.	L.	28.9.22	Osteo-arthritis of hip 2½ years, much pain in knee	Erision of joint after dislocation. Plaster 2 months	Supero-lateral	28.1.24
25	A. W.	50 M.	L.	5.12.22	Hypertrophic osteo-arthritis 6 years, progressive	Erision of joint after dislocation. Plaster 7 weeks	Supero-anterior	23.12.23
26	G. N.	59 M.	R.	2.1.23	Traumatic osteo-arthritis. Fell and broke ankle and hurt hip 3 years ago	Erision of joint after dislocation. Plaster 6 weeks	Supero-lateral	24.1.24
27	C. D.	48 F.	R.	15.5.23	Osteo-arthritis of hip. Pain 2 years. Pott's fracture of R. ankle 8 years ago, position poor	Erision of joint after dislocation. Plaster 2 months	Supero-anterior	7.11.23
28	Pens. P.	33 M.	R.	7.2.23	Hypertrophic osteo-arthritis with commencing dislocation	Erision of joint after dislocation	Supero-lateral	2.2.24
29	Pens. Strat.	38 M.	L.	7.5.23	Traumatic arthritis following fracture of acetabulum. Great flexion and adduction deformity at hip	Partial excision of joint. Dislocation impossible. Plaster 2 months	Supero-anterior	23.11.23
30	G. W.	64 M.	L.	10.6.23	Hypertrophic osteo-arthritis	Erision of joint after dislocation. No plaster fixation. Light extension 6 weeks	Supero-anterior	24.1.24
31	H. S.	48 M.	L.	27.9.23	Hypertrophic osteo-arthritis	Erision of joint, 4 lb. extension. On crutches in 5 weeks	Supero-anterior	24.1.24
32	H. P.	73 M.	R.	4.10.23	Hypertrophic osteo-arthritis 5 years	Erision of joint after dislocation. 4 lb. extension	Supero-anterior	—
33	Lt.B.	24 M.	R.	2.11.23	Chronic painful arthritis 2½ years	Erision of joint after dislocation. In plaster 8 weeks	Supero-anterior	28.1.24
34	G. L.	43 M.	L.	1.8.22	Hypertrophic osteo-arthritis	Erision of joint after dislocation. Fixed in plaster	Supero-anterior	27.1.24

# SURGICAL TREATMENT OF OSTEO-ARTHRITIS 175

## TREATED BY OPERATION—*continued.*

PAIN IN HIP	PAIN IN OTHER JOINTS	FUNCTIONAL SHORTENING	FUNCTIONAL VALUE	REMARKS
None	Some pain in R. hip, both sacro-iliac joints	2½ inches	Can walk 3 or 4 miles	A very short woman. Sacro-iliac pain improved by wearing belt.
None	Pain and stiffness L. knee	2 inches	Can walk a good distance with a stick	Returned to work as carpenter, Nov., 1923
None	None	1½ inches	Good	
None	In R. knee and ankle	2 inches	Fair	Walks with stick, but improving in regard to general function
None	None	1 inch	Good	Could walk 1 to 2 miles 10.11.23. At work as liftman 2.2.24.
None	None	1½ inches	Good	Complete reduction of flexion deformity was easily effected, but full reduction of adduction found impossible
Slight	None	2 inches	?	Walks 2 or 3 miles with a stick 24.1.24
Some in groin after walking	None	2 inches	?	Walks 2 or 3 miles with a stick, hip still feels weak 24.1.24
—	—	—	—	Died 10 days after operation. P.M.; cellulitis of wound; trabeculated bladder; cirrhotic kidneys. Uremic symptoms developed 3 days after operation
None	None	None	Good	Walking in short spica 27.1.24
Some in groin and thigh	Some in back	2 inches	Poor. Can walk half a mile	The resulting position 9 months after operation was fair; flexion and adduction increased latterly, and account for poor end-result

Ozarki<sup>13</sup> in 1917 records the results of the arthrodesing operation of the hip in ten cases of polyarticular arthritis and sixteen of the monarticular variety. The same cases were reported on a few years later.

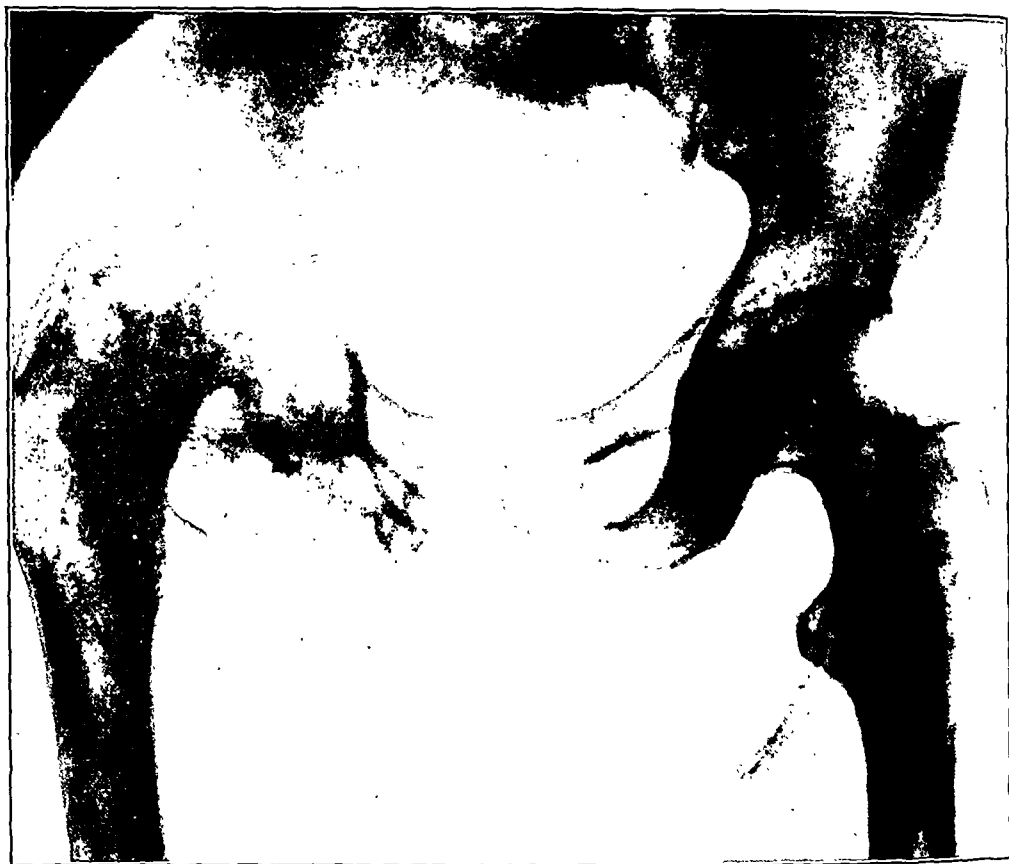


FIG. 137.—Result of operation in *Case 20*: two years after operation: bony ankylosis.

In 1920 Spiers,<sup>14</sup> in a careful survey of the late results of all the cases operated on between 1908 and 1920 at Brackett's clinic, sets them out in tabular form as follows :—\*

Cases operated on	..	..	..	34
Cases examined later and reported	..	..	..	25
Average age	..	..	..	46
Youngest	..	..	..	22
Oldest	..	..	..	61
Case mortality	..	..	..	2
Average interval since operation	..	..	..	4½ yrs.

#### RESULTS OF EXAMINATION.

<i>Union</i> :	Union firm .. ..	17	<i>Position</i> :	Adduction present in	18
	„ questionable ..	3		Normal .. ..	4
	Non-union .. ..	5		Abduction present in	3

\* These cases presumably include those reported in 1917 by Ozarki.

## SURGICAL TREATMENT OF OSTEO-ARTHRITIS 177

He found that in the cases unrelieved by operation, arthrodesis had not been secured.

Albee<sup>7</sup> in 1921 reported that he had operated on 128 cases with satisfactory results. Details of these cases in regard to the technique of operation and the late results are not published.

The results of the operation of excision of the head of the femur for this condition have not been reported in any large series. Individual experience



FIG. 138.—Result one year after operation in Case 24: bony fixation, with head of femur displaced somewhat upwards.

appears to vary. Pain is relieved in all cases, but the functional value of the joint is reported on as a whole unfavourably, considerable shortening being the rule, and stability uncertain (Fock<sup>3</sup>, Zezas<sup>4</sup>, Müller<sup>6</sup>, and Hoffa<sup>15</sup>).

Platt has reported to me that he has carried out a modified excision in some twenty cases. He considers that though pain is thereby relieved surely, the average function given by this operation is disappointing.

I have operated on 31 cases of chronic arthritis of the hip from 1919 to date. Details of these cases are given in *Table I*. The series is made

up of the following types: Monarticular osteo-arthritis, 28; polyarticular osteo-arthritis, 1; traumatic osteo-arthritis, 5. (*See Figs. 137-142.*)

In the 29 cases operated on for chronic arthritis, an erosion of the joint was effected by one of the methods previously described. After-treatment was carried out with a view to obtaining bony ankylosis in 23 cases, and a fibrous joint in 6. Six of these cases were operated on in 1923, and therefore are of no value in assessing the late results.

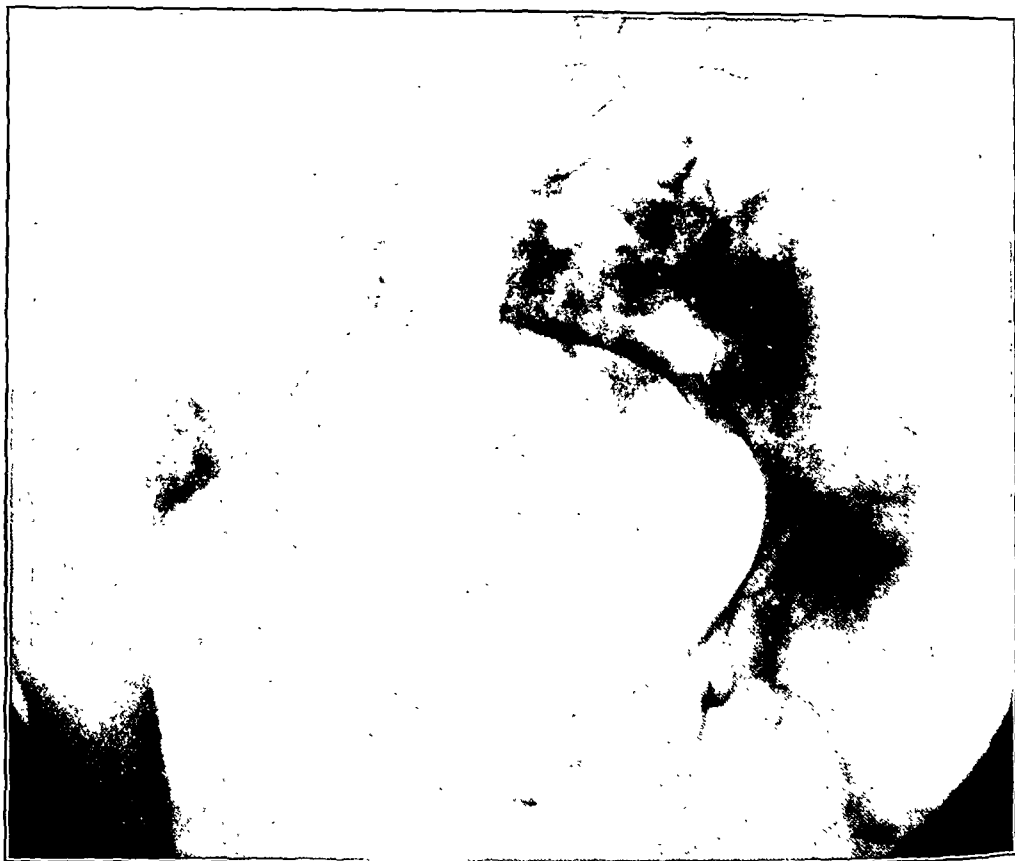


FIG. 139.—Result of operation for osteo-arthritis of hip: fibrous joint: X-ray eighteen months after operation (*Case 25*).

*Table II* gives in outline the late reports of the 24 cases in which operation was carried out between 1919 and 1922. The average age of these cases was 47.5, the oldest was 69 and the youngest 28. The results tabulated were obtained by clinical and X-ray examination made within the last few months. Three of these cases were not examined recently, one having died of pneumonia, one having committed suicide for domestic reasons, and the other reporting from the country. The statements in regard to the absence of pain are based on the patients' opinion, and refer to the original joint pain.

# SURGICAL TREATMENT OF OSTEO-ARTHRITIS 179

The term 'slight pain' is applied to those cases in which ill-defined pain in the groin or thigh was complained of after fixation. The estimate of the functional value of the limb is necessarily approximate. No hard-and-fast classification is possible when dealing with this condition, the results varying in relation to the age of the patient, and the preceding period and degree of disability. The term 'good' has been applied when the patient could walk about five miles without any support, and do a fair day's work. 'Fair' implies the ability to walk about two miles and to stand about half an hour without fatigue. The category 'poor' is applied to those cases in which the ability to walk was limited to a mile or less.

*Table II (abstracted from Table I).—GENERAL RESULTS IN 24 CASES OF ERASION OF HIP-JOINT REVIEWED AT LEAST ONE YEAR AFTER OPERATION.*

CONDITION OF JOINT		POSITION		PAIN IN HIP		FUNCTIONAL SHORTENING	FUNCTIONAL VALUE	
Bony ankylosis	9	Normal	3	Absent	19	Average in inches 1·5	Good	13
Ankylosis ?	5	Adduction	19	Slight	5		Fair	8
Fibrous union	10	Abduction	2				Poor	3

As might be expected, the functional results are most often satisfactory in the younger patients, as is shown in the following table:—

*Table III.—COMPARATIVE FUNCTIONAL RESULTS IN REGARD TO AGE.*

AGE 20-49				AGE 49-79			
No. of Cases	Good	Fair	Poor	No. of Cases	Good	Fair	Poor
14	11	3	0	10	3	4	3

The relation of fixation to function is shown in the following extract:—

*Table IV.—THE RELATION OF FIXATION TO FUNCTION.*

JOINT CONDITION	CASES	RESULTS		
		Good	Fair	Poor
Arthrodesis	9	9	—	—
? Arthrodesis	5	2	3	—
Fibrous joint	10	2	5	3

The nature of the incision employed does not appear to have much bearing on the question of the production of bony fixation. The relative merits of the approaches from a surgical point of view have already been considered.



In the five cases in which the head of the femur was excised on account of a painful ununited fracture of the neck, an attempt was made to effect an arthrodesis. In three cases a beef-bone peg was employed, and in the other two no special means of internal fixation were made use of. In the first three cases arthrodesis resulted, and in the other two a mobile and fairly stable joint was the result.

One fatality occurred in the series: a case (32) operated on in September, 1923. The condition was one of long-standing monarticular osteo-arthritis of the left hip in a man of 75. The patient died nine days after operation with symptoms of uræmia. Post-mortem examination showed cystitis and infection of the kidneys. The fatal issue must be accepted as secondary to operation, but the patient was clearly

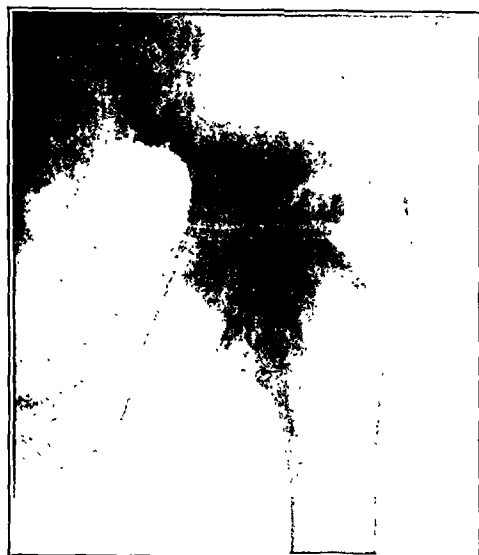


FIG. 140.—Fixation with beef peg after an old excision of head and neck of femur for a wound: X-ray nine months after operation: hip stable, function good.

unfitted for any serious operative procedure.

**The Knee-joint.**—In this joint the accepted opinion is that an arthrodesis resulting from an excision gives good results both with regard to relief of pain and the preservation of the use of the limb. I have carried out the operation in fourteen cases. Bony ankylosis resulted in all. In one case pain definitely persisted after operation. The patient was a man, age 30, apparently in good health. The Wassermann reaction was negative. There is firm bony ankylosis, and he is at work, but he still complains of deep pain in the region of the knee-joint two years after operation.

In two cases complaint was made that pain developed



FIG. 141.—Excision of head and neck of femur, to effect a false joint in right hip (Case 12). The femur has been allowed to drop out, and is not stabilized against the acetabular rim as should be done, by abducting the leg.

in the ankle-joint after much walking. This appeared to be due to development of a rheumatoid change in this joint. In both cases the knee was fixed in the fully extended position, and so the ankle was put through a very full range of movement in the action of walking.

Cases of synovectomy of the knee are reported by Müller and Swett. The former quotes three cases, all of which were stated to have remained relieved from two to four years after operation, the range of movement retained being fair. Swett's records are in relation to polyarticular infections



FIG. 142.—Excision of head and neck of femur for osteo-arthritis, complicating old ununited fracture: femur movable, but stabilized against rim of acetabulum (*Case S*).

of recent origin, and therefore do not come within the scope of the present inquiry. I have carried out this operation in the last two years on four cases of hypertrophic villous synovitis. In all, the recurrent effusion and resulting disability was relieved, and a fair range of movement at the joint attained. It is, however, too early to estimate the ultimate value of the procedure in these cases.

This completes my survey of the subject as far as it can be pursued with the material at present available. I would admit that it is incomplete in

that it lacks a sufficient measure of crucial evidence. I hope, however, it may assist in clearing the ground. It should in some measure define the rôle which can be played by the surgeon in the treatment of certain cases of a common and disabling condition.

In concluding, I desire to acknowledge my great indebtedness for the numerous X rays I have had taken in the investigation of these cases. The Radiological Staff at St. Thomas's Hospital, and Dr. Tindal-Atkinson at Shepherd's Bush, have always cheerfully co-operated, however exacting my demands may have been.

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## EXTRAVASATION OF URINE : WITH ESPECIAL REFERENCE TO PERI-URETHRAL ABSCESS.

BY HAMILTON BAILEY and G. P. B. HUDDY, LONDON.

DURING the fifteen years 1908-22, 107 cases of extravasation of urine from all causes were admitted into the London Hospital as set out in detail in the following table. There was no example of extravasation following ulceration around a urethral or ureteral calculus, nor was there a case of demonstrable perirenal extravasation following injury. As in more than half the cases, the extravasation followed a peri-urethral abscess, the latter will receive major consideration in this paper.

TABLE SHOWING THE SOURCE OF EXTRAVASATION AND THE  
MORTALITY IN THE 107 CASES.

SOURCE OF THE EXTRAVASATION		NUMBER OF CASES	MORTALITY
			Per cent
Peri-urethral abscess	.. ..	65	44
Traumatic rupture of urethra	.. ..	20	20
Injury to urinary bladder	.. ..	13	92
Following suprapubic puncture	.. ..	7	57
Extravasation in infancy	.. ..	1	—
Following internal urethrotomy	.. ..	1	—
		107	

### EXTRAVASATION FOLLOWING PERI-URETHRAL ABSCESS.

This condition frequently complicates urethral stricture of long standing. But stricture does not appear to be the essential factor in causation, because the stenosis in some cases is not sufficient to cause complete retention of urine, and in a few cases stricture is excluded by urethroscopic examination. The determining factor in this catastrophe appears to be a virulent infection of the mucous membrane of the deep urethra extending to the peri-urethral tissues. Some authorities, recognizing this fact, have attributed the whole condition to a spreading cellulitis. Mr. Frank Kidd,<sup>6</sup> however, in a series of cases, demonstrated that a fluid containing 2 per cent of urea could be isolated from the affected area.

**Clinical Features.**—These cases may be divided into three groups: (1) A swelling (peri-urethral abscess) has been present for a considerable period, but recently has increased in size and broken its confines; (2) Whilst straining at micturition, the patient experiences a 'sudden bursting'

in the perineum; (3) A perineal fistula (often of spontaneous origin, and following an abscess) has recently closed.

In severe and neglected cases the general symptoms may entirely mask the local condition. Thus, repeated rigors may be the leading feature of the case, or the patient is seen in delirium or coma.

In contradistinction to traumatic cases, the extravasation is not necessarily confined to those planes defined by the anatomist. It is not exceptional to find the cellular tissues of the thighs and peri-anal regions infiltrated. The probable explanation lies in the fact that the extravasated urine is infected, and suppuration breaks down anatomical barriers. Sir Benjamin Brodie stated that a black patch on the glans penis was a sign of fatal omen; of three such cases in this series, one recovered. It is generally noted that the extravasation proceeds more rapidly on one side than the other. Possibly this is due to the lateral position adopted by the patient in bed, or, as seems more probable, the urethral wall perforates upon the lateral aspect (see *Fig. 143*).

**Differential Diagnosis.**—The diagnosis is usually obvious.

*General.*—The severity of the general signs may, on occasion, mask the local condition; for instance, a case with repeated rigors has been confounded with malaria. Again, if the outstanding feature is delirium, a diagnosis of pneumonia or typhoid may be made, as recorded by Wolfer.

*Local.*—Turning to the local signs, difficulties in diagnosis are occasionally encountered; notably the scrotal œdema may be due to other causes, e.g., anasarca consequent upon a failing heart, or spreading cellulitis from an ischio-rectal abscess. Each of these conditions, simulating extravasation, has been recently observed.

**Mortality.**—The mortality of this condition is exceedingly high. In this series 43 per cent died. The principal causes are septicæmia and uræmia; frequently the two go hand-in-hand.

**Treatment.**—The two great indications in treatment are to mitigate the blood infection and combat the uræmia. The first is carried out by making adequate incisions to relieve tension and admit of the free escape of urine and inflammatory products.

If, as is commonly the case, the patient exhibits uræmic symptoms, the stricture is probably a tight one, and the uræmia is due to retention reacting upon kidneys already seriously damaged by back-pressure, which has extended over a long period. In these cases it is of the utmost importance to relieve the condition by draining the bladder. It is not enough to make incisions into the inflamed area, or even to divide the stricture in addition. The bladder must be drained.

We will now examine the various methods which have been employed in dealing with this condition, and discuss their relative merits. They are: (1) *Multiple incisions only*; (2) *Multiple incisions combined with suprapubic cystotomy*; (3) *Multiple incisions combined with perineal cystotomy*.

1. MULTIPLE INCISIONS, INCLUDING SIMPLE INCISION OF THE PERI-URETHRAL ABSCESS.—For very many years this has been the method most generally adopted. The results are not always satisfactory, for the following reasons:—

In order to treat the condition radically, it is essential to relieve the retention at the earliest possible moment. Once the intra-urethral pressure behind the stricture is zero, the infected urine ceases to be extravasated, and attention can be directed to the cellulitis which invariably follows in its wake.

It might be argued that a peri-urethral abscess is an attempt by nature to perform external urethrotomy, and therefore by incision of the abscess 'the object of surgery' (i.e., to aid nature) is achieved. Unfortunately this simple measure is not always effective; moreover, in some cases there is very little pus or urine to evacuate.

In two recent cases it was noted that wide incision of the abscess did not open the urethra. The condition can best be illustrated by a diagram (Fig. 143). The effectiveness of this treatment is to a large extent governed by the size of the opening B. Since the opening is usually small and laterally placed, more thorough treatment is indicated. Simple incision should be reserved for desperate cases.

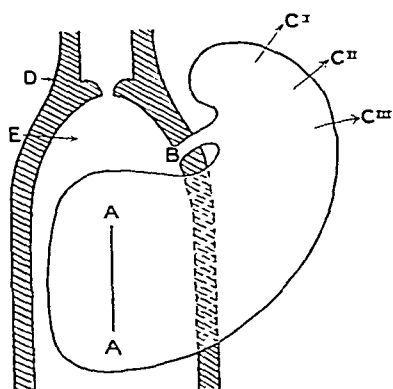


FIG. 143.—Diagram illustrating wide incision of abscess without opening urethra. A-A is an incision into the peri-urethral abscess which communicates with the urethra through a small lateral orifice (B) behind the stricture. C<sup>I</sup>C<sup>II</sup>C<sup>III</sup> is that part of the abscess wall which has given way, and through which urine and pus are extravasating. D, Stricture. E, Dilated urethra.

2. MULTIPLE INCISIONS COMBINED WITH SUPRAPUBIC CYSTOTOMY.—This is strongly recommended by Wolfer. The method has the very obvious disadvantage that the cystotomy incision of necessity traverses the infected superficial planes, and thus infection may be carried to the cave of Retzius. If this occurs there is the danger of deep pelvic cellulitis, a very grave complication which proved fatal in one recent case under observation. Further, if the bladder is much distended and the patient uræmic, the immediate effect of a suprapubic cystotomy will be to depress the renal efficiency still further and thus very possibly hasten a fatal termination.

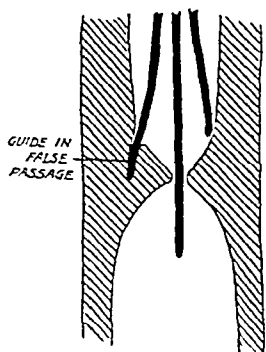


FIG. 144.—'Faggot' method of introduction of bougies.

3. MULTIPLE INCISIONS COMBINED WITH PERINEAL CYSTOTOMY.—This appears to be the method of choice, and therefore will be set out in detail.

*Preliminary Urethroscopy* to ascertain the site and estimate the calibre of the stricture if one is present.

*The Urethra is Washed out*, and novocain is instilled. The additional injection of methylene blue into the urethra in order that the mucous membrane can be more readily recognized, during the perineal stage of the operation has been found to be disappointing—

for necrotic tissues do not readily take up the stain.

*An Attempt is made to pass a Bougie into the Bladder.*—Great gentleness is exercised, for the urethra, being inflamed, may easily be perforated.

However, it is usually possible to pass a No. 3 or No. 4 French. In the absence of an instrument by which the bougie can be passed under direct vision, the 'saggot method' (*Fig. 144*) of introduction is of distinct value. The introduction of a guide simplifies the subsequent stages of the operation. If the bougie has been passed, it should be fixed in position. The patient is now anaesthetized. Spinal stavaine is indicated, for the uræmic condition of the patient renders a general anaesthetic dangerous.

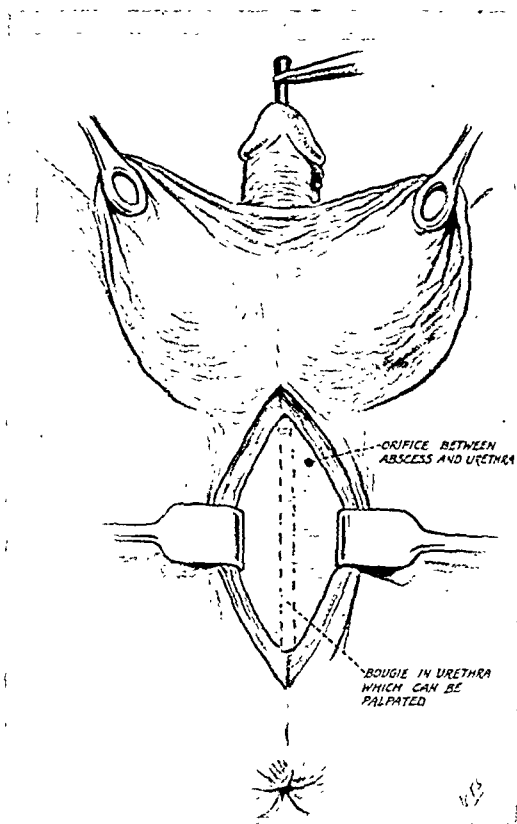


FIG. 145.—Showing position of bougie in the urethra.

*a. If the bougie has failed to pass through the stricture: Wheelhouse's operation should be performed.*

*b. A bougie has been passed* (which will be found possible in the majority of cases): The patient is now placed in the lithotomy position, and a sand-bag placed under the scrotum to exaggerate effectively this position. Lane's tissue forceps are clipped upon the most dependent part of the infiltrated scrotum. These serve as scrotal retractors. By this method the scrotum is pulled up and the perineum is clearly exposed to view. Towels having been arranged, an incision is made from the base of the scrotum to within  $\frac{1}{2}$  in. of the anal verge, keeping strictly to the middle line. The tissues in this region being extensively infiltrated, it is usual to find that one has to proceed to a depth of  $\frac{3}{4}$  in. or more before the abscess is reached. Urine and pus then escape, usually under considerable pressure.

A finger is now passed into the wound, and the bougie within the urethra (*Fig. 145*) sought for by palpation. Retractors are then placed in either side of the wound, and the urethra is inspected. A head light is very useful at this stage. The breach in the continuity of the urethra can sometimes be seen. There was a hole admitting a probe in the lateral aspect of the necrotic urethra in two cases recently observed. The floor of the urethra is incised and the edges are retracted. The left index finger is passed into the dilated urethra, with the pulp against the bougie. The finger is thus guided into the bladder. A large coude catheter is then passed through the incision along the index finger into the bladder, and secured to one side of the wound with a stitch.

It is inadvisable to withdraw more than one pint of urine if the bladder is greatly distended. The residue is evacuated at intervals of four hours.

*Drainage of the Cellular Tissues (Fig. 146).*—The left forefinger is now passed through the perineal wound, upwards and outwards, clearing the crus penis, and made to protrude subcutaneously above and to the outer side of the symphysis pubis (*see Fig. 147*); the skin is then incised over the finger, and long blunt-nosed forceps retrace the path and emerge in the perineal wound. The jaws are opened and grasp a  $\frac{1}{4}$ -in. drainage tube, previously perforated, which is then pulled up and fixed by a stitch. This procedure is repeated on the opposite side.

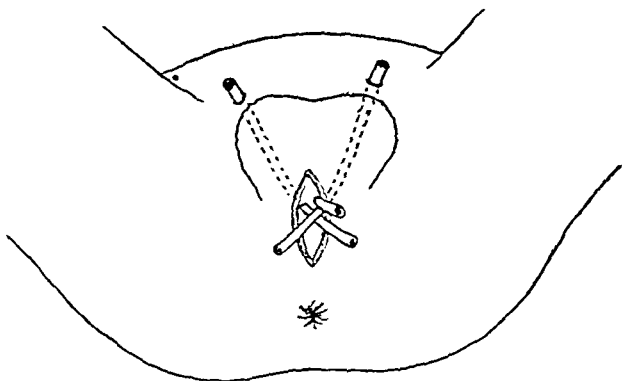


FIG. 146.—Method of drainage (after Hartmann).

*Incisions into the Infiltrated Tissues.*—In contrast to the older methods,

fewer but larger incisions are recommended. There is a tendency, on account of the infiltration, for the incisions to be too superficial; they must be of sufficient depth to penetrate the limiting fasciæ.

*Injections of Hydrogen Peroxide.*—It has been shown that anaerobic organisms are largely responsible for the spreading cellulitis in these cases (Jungano). As oxygen is inimical to these organisms, hydrogen peroxide is injected into the subcutaneous tissues around the incisions by means of a Crile's anoci-association syringe, fitted with an angular needle.

*Dressings.*—Moist dressings of eusol are applied over the abdominal wall, perineum, and scrotum; these are covered over by packing towels, and the whole is secured by a T-shaped bandage.

*After-treatment.*—During the first twenty-four hours the patient is encouraged to drink as much fluid as possible; rigors are usual during this

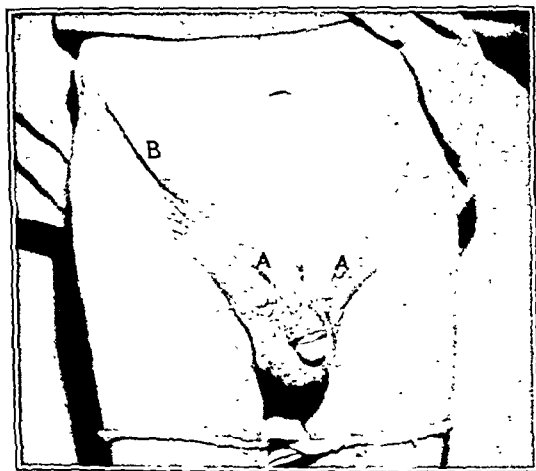


FIG. 147.—Patient convalescent from peri-urethral abscess with extravasation. A, A. Site of subcutaneous tubes referred to in text; B, A long incision into the infiltrated tissues.



period, and are most successfully combated by hot gin and quinine. The catheter is removed at the end of forty-eight hours. Every four hours all the wounds are irrigated with eusol through a Higginson's syringe, after hydrogen peroxide has been instilled for a few minutes. At the fourth day shortening of the tubes should be commenced. As soon as the general condition permits, sitz baths are instituted.

*Drugs.*—Acid sodium phosphate and hexamine, combined with tincture of hyoseyamus, are given in liberal doses.

*Residual Abscess.*—This is frequently seen in the flank just above the anterior superior iliac spine. Under gas anæsthetic the abscess should be freely opened.

When the infection has subsided, which is usually in about three to four weeks, the treatment of the perineal fistula should receive attention. If the stricture has not been divided, an internal urethrotomy with insertion of a catheter is an effective method of dealing with the condition and hastening the closure of the wound. Occasionally it may be possible simply to dilate the stricture with bougies.

The patient should not be discharged until the fistula is closed, and the stricture must then be dilated regularly.

### EXTRAVASATION FROM OTHER CAUSES.

**Ruptured Urethra.**—Under the title of ruptured urethra there are included two entirely distinct clinical entities:—

*a.* The first consists of the classical cases due to a fall astride and resulting in a complete or incomplete tear of the bulbous urethra. Of 47 cases of ruptured urethra of this type admitted to the London Hospital during the period under consideration, only 11 were complicated by extravasation of urine.

*b.* This comprises those cases in which the urethra is torn above the anterior triangular ligament—the morphological bony pelvis. There were 9 examples in this series. This variety is a direct complication of fractured pelvis, and the extravasation occurs into the cave of Retzius.

The differential diagnosis between an intrapelvic rupture of the urethra and an extraperitoneal tear of the bladder is usually a matter of profound difficulty. The diagnosis in the majority of cases is uncertain until a suprapubic incision has been made. Even then some difficulty may be encountered in determining the exact site of the lesion amidst the blood-stained effusion. There is, however, one guiding rule: if the bladder is even moderately distended, the lesion must be situated below the vesical sphincter.

**Injury to the Urinary Bladder.**—Extraperitoneal, 5; Intraperitoneal, 4; Extra- and intraperitoneal, 4; Total, 13. Nine of these followed an abdominal contusion or a fractured pelvis; two were consequent upon catheterization and irrigation of a dilated atrophic bladder secondary to enlarged prostate: at necropsy the bladder showed a perforation at the fundus in both instances. There was one example of extravasation following an injury to the bladder during an operation for the relief of strangulated

femoral hernia. Lastly, there was a case following normal parturition, and this is so exceptional as to warrant some reference to the details.

A primipara, age 28, was confined five days previously and delivered, without forceps, of a healthy child. On admission the condition was desperate. There was great abdominal distention and faecal vomiting. Laparotomy was immediately performed, the peritoneal cavity being drained through a sub-umbilical incision. The patient died a few hours later.

A necropsy showed general peritonitis due to extra- and intraperitoneal tears of the posterior part of the fundus of the bladder: the surrounding mucosa was injected and sloughing. There was a uterine tear limited to the cervix.

**Extravasation following Suprapubic Puncture.**—Seven cases followed aspiration of the bladder for relief of acute retention.

At operation, in two of the most recent examples of extravasation from this cause, a puncture of the vesical wall through which urine was escaping could be clearly seen. Therefore simple suprapubic puncture is a method not devoid of danger. It is obvious that, unless the cause of the retention has been removed before the bladder again becomes tense, there is always a risk of leakage occurring at the site of the puncture. If urine thus extravasated is infected, pelvic cellulitis must ensue. The introduction of a catheter through a suprapubic trocar of suitable dimensions obviates this complication, for the intravesical pressure remains minimal. There was no case of extravasation in this series following the latter method.

**Extravasation of Urine in Infancy.**—In this series there is but a solitary example of this very rare condition.

A male, age 6 weeks, was admitted with acute retention and extravasation into the scrotum and far up the abdominal wall. Temperature 104°. External urethrotomy was performed, and combined with multiple incisions. The child died.

A necropsy showed a purulent external urethrotomy wound leading into a lacerated urethra and communicating with a peri-urethral abscess in front of the triangular ligament. There was gangrenous cellulitis of penis, scrotum, and cave of Retzius, and an abscess in the right lobe of the prostate. The meatus was of normal calibre, and there was no phimosis. The bladder was distended and hypertrophied, and the kidneys showed parenchymatous degeneration and pin-head abscesses. Slight seropurulent leptomeningitis in the Sylvian fissure and over the right temporal lobe was associated with cerebral softening and embolism of the right cerebral artery.

The cause of the extravasation in this extremely interesting condition was obscured at necropsy by the purulent external urethrotomy wound, which precluded the possibility of a precise diagnosis. As there was no evidence of meatal stenosis or of urethral calculus, it seems probable that this was a case of congenital stricture of the deep urethra.

**Extravasation following Internal Urethrotomy.**—This is a very rare complication of the operation. The danger would appear to lie in the passage of the pilot into a false passage.

A greengrocer, age 53, had suffered for some months with dysuria, culminating in strangury: for twenty-four hours before admission he had absolute retention, which was relieved by a hot bath. Four days later, under gas and novocain, an internal urethrotomy was performed, and was followed two days later by a typical extravasation. The treatment consisted of multiple incisions and the insertion of a silver catheter. The patient sank, and died in coma.

Necropsy revealed cellulitis involving the penis, scrotum, and abdominal wall. There was a stricture 1.7 cm. long in the bulbous urethra. A false passage led into a purulent sinus at the side of the stricture, and extension of the sinus passed upwards along the corpora cavernosa and communicated with a large abscess of the left lobe of the prostate.

After completing the foregoing, and being desirous of finding the exact source of Brodie's observation that a black patch on the glans penis was a harbinger of death (which Mansell Moullin referred to in his text-book of 1891), we consulted the works of Sir Benjamin Brodie. So full of interest are Brodie's observations on this subject that we beg leave to quote verbatim from his *Diseases of the Urinary Organs*, 4th edition, 1849.

"Sometimes a black spot is seen on the glans penis: an almost fatal symptom, indicating that the whole of the corpus spongiosum is infiltrated with urine. . . .

"But the danger from the effusion of urine is not the same in all cases. In the majority the effusion takes place in front of the triangular fascia of the perineum, or else the fascia gives way and allows the urine to pass forward to the superficial parts instead of penetrating to the deep-seated; and under these circumstances life may generally be preserved by the prompt interference of the surgeon. In a very few cases the effusion extends into the loose cellular membrane which surrounds the bladder, and the patient's condition is hopeless.

"Where the urethra has given way behind the stricture, and the urine has become effused into the cellular texture, very prompt and vigorous measures are necessary: delay is fatal. I remember the time when five out of six of the patients in whom this mischief took place perished; but now, from the more active treatment employed under the hands of a well-informed surgeon, the great majority recover.

"I have already mentioned that the effusion of the urine is followed by a relaxation of the stricture. You will probably now be able to introduce a catgut, or some other bougie (a catgut one is to be preferred), through the stricture into the bladder. If you can do so, it is so much the better. Introduce the bougie; let the patient be held in the position in which you would place him for lithotomy; make an incision in the perineum; feel for the catgut bougie, and make an incision on it; of course, you make an opening in the urethra. Through this opening, the catgut bougie serving you as a director, introduce a short gum catheter from the wound in the perineum into the bladder. You will generally find, although the effusion of urine has taken place, that there is still a large quantity of urine left in the bladder. Of course, it is drawn off by the catheter, and the bladder is emptied. Allow the catheter, however, to remain in the wound and in the bladder. Then make extensive scarifications or incisions through the skin, wherever the urine has been effused underneath, and let these incisions extend to the sloughs of the cellular membrane."

Thus, over three-quarters of a century ago Brodie devised a technique which reduced the mortality of this condition from "five out of six" to "a recovery of the majority".

Under modern condition and advantages, would not the adoption of the

basic principles of the great pre-Listerian master improve the prognosis of this, the commonest variety of urinary extravasation?

We beg to record our thanks to the surgeons of the London Hospital, and particularly to the director of the Genito-Urinary Department—Mr. Hugh Lett—for his invaluable help in the preparation of this article.

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## THE MEDIAN EXTRAPERITONEAL ROUTE TO THE URETER.

By K. W. MONSARRAT, LIVERPOOL.

THE routes commonly employed in ureteral lithotomy are: (1) The lumbar; (2) The inguinal; (3) The transperitoneal. It may be confidently stated that the sacral, perineal, vaginal, and rectal routes are not now followed.

1. The lumbar route has a limited use in those cases where a calculus is lodged in the renal end of the ureter, and the incision and subsequent steps of the operation are as for a pyelotomy.

2. The inguinal operation is either a muscle-cutting or a muscle-splitting operation or a combination of these. It gives excellent access to the calculus which is arrested about the pelvic brim, but indifferent access to one in the depth of the pelvis. If a calculus cannot be milked upwards, the suture of the ureteral wound is difficult.

3. For the transperitoneal route the advantage of palpation of the opposite kidney and ureter was claimed, but no longer carries weight. While the route has the advantage of being short and direct, it is generally felt by surgeons to be undesirable. It inevitably adds to post-operative discomfort, and is attended by some risk of infection.

I am aware of the combination of a transperitoneal exploration and an extraperitoneal exposure, but have no experience of its usefulness.

I wish to testify to the great technical advantages of a median suprapubic incision down to the peritoneum, followed by extraperitoneal exposure of the ureter by peritoneal displacement. The steps of the operation are as follows: An incision is made from umbilicus to pubis, the aponeurosis is divided to the same extent, the recti are bluntly separated, and the extraperitoneal plane is reached. If the calculus is in the right ureter, separation of the peritoneum proceeds on that side towards the iliac fossa, continued round the pelvic basin until the common iliac bifurcation is reached, when the ureter is found and comes off the vessel with the peritoneum. A large broad-bladed retractor is then inserted, and displaces inwards the peritoneal sac and its contents. The ureter is then traced to the point of impaction of the calculus, and this is displaced as may be thought desirable, and removed. After suture of the ureteral wound a stab wound is made through the abdominal wall in the right iliac fossa through which a half tube passes towards the site of the ureteral mend. Retractors are then removed, the peritoneum falls back into place, and the median wound is sutured throughout its length.

Apart from a somewhat similar procedure for cases of bladder resection, I first employed this method for the removal of a ureteral stone in the following case: On Nov. 11, 1920, I removed an adenomatous prostate by

suprapubic enucleation from a patient 57 years of age. He was a healthy man of powerful physique, weighing some 16 stone. On Dec. 6, 1921, I removed a calculus from his bladder and another from the lower end of his left ureter. The bladder was reopened through his suprapubic scar and the vesical calculus removed. By peritoneal stripping between bladder and left pelvic wall the ureter was exposed and the calculus here removed. I had expected to be able to remove it through the left ureteral orifice from inside the bladder, but this proved impossible. He left the home healed four and a half weeks later.

I have used the same procedure on many occasions since then, the last example being the following: A male patient, age 32, an engineer by occupation, was admitted to the Northern Hospital on Feb. 16, 1924, complaining of blood in the water and pain in the right side. He stated that the first attack of pain occurred in August, 1921, and that he then noticed blood in the urine. He had had several attacks of the same kind since.

Radiographic report: "There is a shadow in the pelvic region on the right side in the line of the ureter which may be a calculus, but its long axis is not in the direction of the ureter." A fair number of red blood-cells were present in the centrifugalized urine deposit. The right kidney was not palpable. Although the radiologist's report was not definite, the diagnosis of ureteral calculus was considered positive.

On Feb. 26 an incision was made from umbilicus to pubis. The extraperitoneal plane was opened up below, and the peritoneum stripped from the right pelvic wall until the ureter was reached. The calculus was easily found and displaced upwards, the ureter was incised, and the calculus removed. The ureter was explored with catheter upwards and downwards, and the wound then sutured with catgut 000. A stab wound was made through the abdominal wall an inch inside the anterior superior spine, and a half tube passed to the site of the ureteral wound. The retractors were then removed, and the suprapubic wound was sutured with interrupted catgut stitches and supporting through-and-through stitches of silkworm gut.

The drainage tube was removed in forty-eight hours, the dressing being dry. He was discharged from hospital eighteen days after operation.

## *VISITS TO SURGICAL CLINICS AT HOME AND ABROAD.*

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### **THE CLINIC OF PIERRE DUVAL, PARIS.**

A SMALL group of surgeons visited the clinic of Professor Pierre Duval in Paris recently. This is a record of the impression made upon them of what they saw there. The time spent in the clinic was brief, so that the insight into the activities engaged in by the workers of the institution was necessarily limited. L'Hôpital de Vaugirard contains nearly 200 beds, all of which are under the direction of the Professor. We have no entity corresponding to it in this country; it is not comparable with the surgical division of one of our hospitals, as will be seen from what follows: it is described as a 'clinique thérapeutique chirurgicale', a quite untranslatable expression, as it implies a definite unit such as is unknown over here. The staff is a large one. There are an assistant professor and two assistant surgeons (chefs de clinique chirurgien), one physician, two foreign surgical assistants, three surgical internes, and ten externes. These are members of the ordinary surgical service; and in addition there are a urologist, gynaecologist, oto-rhinolaryngologist, oculist, dentist, and two radiographers, whilst in the special department for gastro-enterology there are three physicians. There are two chemical laboratories and also a combined pathological and bacteriological laboratory, all of which have their own adequate staffs.

The hospital receives a large grant from public funds, and the Professor is allowed great latitude, not only in the expenditure of this money, but in the plan of administration of his clinic. There is plenty of room for individual expression, and it seems the object of the State to foster originality by freeing the Professor from the hampering shackles of State control. An outstanding feature of the clinic is a vitality of outlook and an all-pervading spirit of investigation. Research takes a more prominent part than undergraduate teaching, though this is not lost sight of by any means. Professor Duval holds that prolonged undergraduate teaching is mentally sterilizing, and that after a number of years only advanced teaching should be required of the head of a large clinic. He therefore relegates undergraduate teaching to his staff, confining himself to post-graduate and advanced instruction. At present he is concerned particularly with diseases of the digestive tract, and it is interesting to see how the problems arising out of this study are tackled. The physicians, radiographers, and pathologists all see the patients clinically with him, whilst they all witness the radiographic examination and the operations performed, should such be decided upon. No case is radiographed without the Professor being present. In this clinic there is no such thing as one

member of the team falling behind in his knowledge of his colleagues' special departments. Nothing but good can come from such a system. It makes co-ordination a real thing, but it is necessarily exacting in the time and energy demanded from all the members of the clinic.

A great deal of research is being carried on in the radiographic appearances of affections of the duodenum and gall-bladder. A wonderful selection of photographs was exhibited. Pierre Duval claims that he can diagnose 40 per cent of gall-stones by direct radiography, and another 40 per cent from indirect radiographic evidence. From the perfection of technique shown to the visitors, this is easily credible. M. Bécélère, the radiographer, has

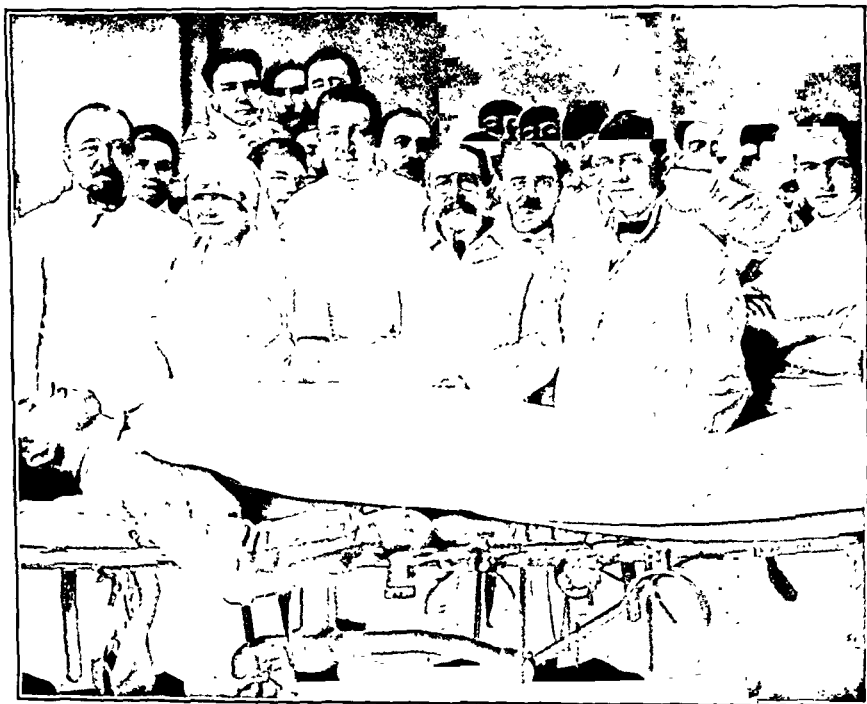


FIG. 148.

invented a very ingenious apparatus by which a number of films of about half-plate size can be exposed in rapid succession, up to thirty, in the minute. The films in separate holders are loaded in the apparatus used for screening in the erect position. The opaque meal is watched as it passes into the duodenum, and at any moment a photograph can be taken without moving either the patient or screen. In studying the duodenum and gall-bladder great use is made of lateral views. Some radiographs of chronic duodenal ileus due to obstruction by the superior mesenteric artery were shown, and it was explained how such obstruction, present in the erect position, is relieved when the patient lies prone. The many points by which gall-stones render



their presence evident were gone into, such as the movement of the shadows with change of position of the patient, their situation in profile view in relation to the spine, the distortion of or dragging on the duodenum.

Some interesting skiagrams illustrating the surgical treatment of Pott's fracture were demonstrated, and the method employed was explained. Immediately the patient is admitted, a spinal anæsthetic is given and reduction attempted on the X-ray couch. Should it be successful, a plaster cast is applied; but if all efforts are ineffective, operation is proceeded with. It consists in the fixation of the fragments in proper position by means of screws. An original method of photographing the elbow or knee-joint in a flexed position was demonstrated. The limb is bent over an earthenware jar, round which is wrapped the X-ray film. The tube, by a clever removable projection apparatus, is centred accurately over the joint space, and the skiagram taken. Photographs were exhibited which clearly proved that in this way the joint space in the knee appears much larger than by the usual method, whilst by this technique alone can certain loose bodies in the joint be detected.

A tour of the laboratories was made, and in the lecture room was seen a simple and cheap apparatus for projecting diagrams and solid objects on the screen (episcope).

The next day several operations were witnessed. The operation theatre itself is a large room with walls green to diminish eye-strain. It contains literally nothing beyond an operation table, anæsthetist's stool, anæsthetist's table, and instrument and dressing tables; not even a gallery for spectators. There are no rows of bottles on shelves, or apparatus of any other kind. The walls are perfectly smooth. The actual operative technique is interesting from many points of view. For abdominal work, local and conduction anæsthesia are not used. The Professor has found the incidence of lung complications after these methods as great as, if not greater than, after inhalation anæsthesia. The Clover apparatus is used for the administration of ether. The operator and his two assistants wash and dress in a neighbouring room. The patient is strapped to the table. The instruments in a metal container are sterilized by dry heat, a separate set for each case. They are placed in their container on the operator's table. He selects and handles his own instruments, whilst ligatures are looked after by his assistant, who has them on his own table. Behind the instruments are placed the drums containing the dressings; their completely detachable lids which envelop the whole drum are removed by the sister. The operator helps himself to towels and swabs. No nurse is washed up to take part in the operation. The nursing staff simply convey to the operator instruments or dressings in sterilized containers. Non-absorbable suture material is used for most intestinal anastomoses and for the stomach. Catgut is only used within the abdomen for septic cases. It is employed for suturing the muscles of the abdominal wall, but not for the peritoneum. Access to the operation area in the abdomen is gained by the free use of large retractors. Thus, when operating upon the upper abdomen, a large Doyen retractor is inserted in the upper angle of the wound. All sewing is done by means of Reverdin needles of different sizes: this makes for rapid work with a perfectly trained assistant.

The first operation was for a duodenal ulcer situated at some distance from the pylorus. A posterior gastrojejunostomy was performed without clamps, and the pylorus closed by a single encircling suture. M. Duval says he has met with but one gastrojejunal ulcer, and attributes this to the fact that he does not use clamps.

The second patient had a number of adhesions around the duodenum, and was described as being a case of simple periduodenitis due to disease of the gall-bladder without stones. The adhesions were separated and cholecystectomy performed. The gall-bladder was removed from the neck towards the fundus. No drainage was provided. The operator explained that only in 10 per cent of cases was it possible to close the abdomen without drainage, the ability to make a proper peritoneal covering for the stump of the cystic duct determining the possibility of doing this.

The third case had been diagnosed as one of simple periduodenitis, but it proved to be chronic duodenal ileus. This made the thirty-second case of the kind upon whom the Professor had operated. A duodenojejunostomy was performed.

The last case was gynaecological in nature, an ectopic gestation. The affected tube was removed. Catgut was used in the abdomen in this patient.

The speed at which technique is carried out in this clinic can be gathered from the fact that these four operations were performed in two hours and ten minutes, although there were considerable intervals between them, the same anaesthetist acting in each case. The character of the operating was to perform the essential steps in the shortest possible time and return the patient to bed, neglecting certain niceties of technique upon which stress is laid by some surgeons. The theatre was kept unusually hot, with the idea apparently of diminishing the risk of subsequent bronchial affections. For the first few days after the operation the patients are kept in separate cubicles before being returned to the general wards. The perfection of organization of the whole hospital is illustrated by a small point. Each patient has an electric bell-push. Should he ring for help a red lamp glows outside his cubicle, and remains alight until extinguished by the answering nurse.

One came away from the clinic impressed with the dynamic atmosphere pervading it, with a feeling that advance in knowledge must proceed from such a system, and convinced of the essentially sound policy adopted by the State of granting an unusual liberty of action to its professors, in the belief that only in this way can real progress be made.

*SHORT NOTES OF  
RARE OR OBSCURE CASES*

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**AN OBSCURE CASE DUE TO CALCULUS IN THE PELVIS  
OF AN ECTOPIC KIDNEY.**

BY HUGH REID, LIVERPOOL.

THE case was under the care of Mr. Thelwall Thomas at the Royal Infirmary, Liverpool, and seen by the writer as surgical registrar. The patient is a male, age 28.

**HISTORY.**—He gave a history of attacks of pain in the left lower lumbar region for the last three years. This was accompanied by frequency of micturition and the passage of dark-coloured urine. Lately the attacks had been becoming more frequent and severe, and the intervals of relief shorter. The pain was of a cutting nature, starting in the left lumbosacral region and shooting towards the groin. It lasted about twelve hours, and was followed by what the patient thought was blood in the urine. At the same time he suffered from pain in the suprapubic region, which passed some way down the penis.

ON ADMISSION, in November, 1923, the man looked healthy. He lay easily in bed; the abdomen moved normally with respiration; no abnormal swellings, or rigidity or tenderness, were detected. The urine showed a few blood-cells, but no crystals. Pus-cells and epithelial cells were seen in direct films. Staphylococci were grown on culture.

The X-ray report (by Dr. R. E. Roberts) was: "Stone in bladder" (*see Fig. 149*).

On Nov. 29 Mr. Thomas passed a lithotrite, but no stone was felt. A sound was then passed and a careful exploration of the bladder made, without result. A cystoscope was substituted for the sound, but nothing abnormal was seen in the bladder. The patient was sent away for another skiagram.

On Dec. 4 a further X-ray report stated: "Same shadow in practically the same place, but rotated on its axis. The only other two possibilities are (1) calcareous gland of unusual appearance, or (2) stone in a much distorted ureter. The shadow is not so clear cut as one would expect in the case of a ureter stone. The whole thing is atypical".

On Dec. 6 cystoscopy showed pus coming from the left ureteral orifice. The right ureteral orifice was normal. From this it was decided that the condition was due to stone low down in a much dilated ureter.

**OPERATION,** Dec. 12, by Mr. Thomas.—Split muscle incision over left iliac fossa. Ureter not found. The kidney was then discovered to be placed

entirely below the brim of the bony pelvis. The organ could not be brought out of its bed through the wound. Renal vessels were arising from bifurcation of common iliac artery. Part of the kidney substance and the renal pelvis were incised, and a typical calcium oxalate stone was removed. The renal pelvis was sutured, and the wound closed with split rubber drainage tube down to the kidney.

On Dec. 26 the patient was discharged after a normal convalescence. The specimen measured  $1\frac{1}{16}$  in.  $\times$   $\frac{1}{8}$  in., and weighed 94 gr.; it was oval in



FIG. 149.—Calculus in pelvis of ectopic kidney.

shape, pale brownish yellow in colour, and the surface was covered by sharp glistening crystals.

A review of the literature of ectopic kidneys is given by Dorland<sup>1</sup> in 1911, and nineteen cases are reported by Judd<sup>2</sup> in 1919, in one of which stones in the pelvis and calices of a pelvic kidney were discovered.

#### REFERENCES.

- <sup>1</sup> DORLAND, W. A. N., "A Consideration of Renal Anomalies; with the presentation of Two Unique Cases", *Surg. Gynecol. and Obst.*, 1911, xiii, 303.  
<sup>2</sup> JUDD, E. S., and HARRINGTON, S. W., "Ectopic or Pelvic Kidney", *Ibid.*, 1919, xxxviii, 446.

## AN ABNORMAL FIRST RIB FORMING A SUPRACLAVICULAR TUMOUR.

By C. HAMILTON WHITEFORD, PLYMOUTH.

THE patient is a girl, age  $3\frac{1}{4}$  years. The mother first noticed a 'lump' in the right side of the neck when the child was two years old. One inch above the centre of the right clavicle there is a tumour which projects the skin. On palpation there is found, immediately beneath the skin, a curved, fixed body

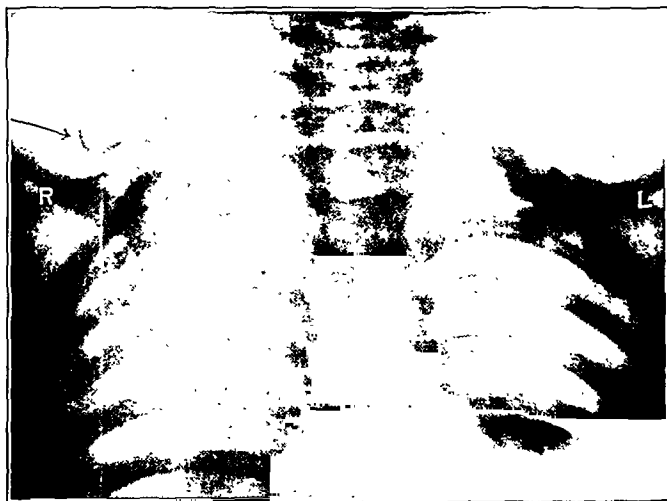


FIG. 150.—Girl, age  $3\frac{1}{4}$ , with an abnormal first rib. A, Curved lead wire to mark projection beneath skin.

of the shape and consistency of a rib. There is no pulsation, and nothing resembling blood-vessels or nerves can be felt between the tumour and the skin. There are no symptoms, and the shoulder movements are normal. No abnormality is visible or palpable in the left side of the neck. The skiagram (taken with the child lying on her back on the plate) shows that the first dorsal vertebra has, on its left side, a normal

first rib, but on its right side a rib which appears as a horizontal straight bone  $1\frac{1}{2}$  inches in length (*Fig. 150*). Actually this rib is much longer, and curved from behind forwards. A palpable and visible supraclavicular tumour formed by a first dorsal rib appears to be a rare abnormality. The mother, who had been urged at a hospital to have the bone removed at once, "to prevent paralysis of the arm", was advised that it would be time enough to think of an operation if pain or weakness should occur in the arm, and that such symptoms might never appear.

## ACUTE COLIC INTUSSUSCEPTION IN A CHILD.

By W. E. TANNER, LONDON.

THE patient, a girl, age 2 years and 9 months, was admitted to hospital on March 30, 1924. She was an artificially-fed baby, and had pneumonia when one year old. Her general health was good, and she is a strong, healthy child.

At 9 a.m. on March 27 she fell down eight stairs. She was apparently uninjured, and the bowels were open normally during the course of the

morning. She was quite well until 1 p.m., when she refused her dinner and complained of pain in the lower abdomen. She was put to bed and went to sleep for half an hour. She woke up screaming, with violent abdominal pain which lasted for a quarter of an hour, but no vomiting. The pain continued for the rest of the day, with short periods of quiet. During the night the pain continued, and she kept asking for the chamber, but with no result. Tenesmus was marked, and the legs were drawn up on the abdomen.

On March 28 she seemed better, but was cross, and demanded to be nursed all day. The bowels were not open, and in the evening she had more pain and was taken to a doctor. She was given medicine, following which she vomited, and the mother said there was blood in the vomit. She refused food and drink all day, and at night the pain became much worse, with tenesmus. A little blood and mucus was passed. On March 29 the patient was easier in the morning but drowsy all day. The pain was not so severe, and there were long intervals of freedom. The bowels were not opened, and at night the pain became worse, with frequent vomiting and tenesmus. On March 30 the pain was worse in the morning, and not relieved by a hot bath. The mother was frightened by a 'peculiar look in the child's eyes', and, after consulting her doctor, brought the child to hospital.

On admission, temperature was 97°, pulse 90, respirations 30. The child looked ill and drawn. There was marked general distention of the abdomen, and a hard, sausage-like tumour was felt in the left iliac fossa. On rectal examination, an intussusception could be felt, just within reach of the finger. On withdrawing the finger from the rectum, a gush of blood and mucus followed.

Operation was performed on March 30 at 2.30 p.m.: right paramedian laparotomy. Blood-stained fluid escaped from the peritoneal cavity. The intussusception was reduced by gentle pressure from below. On reduction it was seen that it was colic, and had commenced at the splenic flexure of the colon. No polyp or other abnormality was found to account for its occurrence. The pelvic colon was elongated, and the descending colon had a complete mesentery and was freely movable. The wound was closed in layers. The patient made an uninterrupted recovery.

Acute colic intussusception is comparatively rare. In Perrin and Lindsay's<sup>1</sup> series it formed 5.6 per cent of 335 cases. All the idiopathic cases occurred before the seventh year. In my own series of 30, this is the first example of an acute colic intussusception. The length of the history, seventy-four hours, is of interest. In Perrin and Lindsay's series the average length was thirty-three hours. Was the accident responsible for the sequence of events? This appears to have been as follows: Elongation and distention of the pelvic and descending colon; spasm of the distal half of the transverse colon as far as the splenic flexure; irregular peristalsis; formation of an intussusception at the splenic flexure, a fixed portion of the bowel, which may have been damaged as a result of the fall downstairs.

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#### REFERENCE.

<sup>1</sup> PERRIN and LINDSAY, *Brit. Jour. Surg.*, 1921, ix, 46.

## REVIEWS AND NOTICES OF BOOKS.

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**Chronic Intestinal Stasis (Arbuthnot Lane's Disease): A Radiological Study.**  
By ALFRED C. JORDAN, C.B.E., M.D. (Camb.), M.R.C.P. (Lond.), Corresponding Foreign Member, Belgian Royal Academy of Medicine. 4to. Pp. 230 + xi, illustrated. 1923. London: Oxford Medical Publications. 25s. net.

CHRONIC intestinal stasis is here dealt with partly from the point of view of the radiologist, though the subject matter is by no means confined to radiological considerations. The author outlines the views held by Sir W. Arbuthnot Lane on the alimentary tract, and attempts to correlate them with the X-ray appearances of the opaque meal and enema in health and disease; the result is not always a happy one, as he frequently makes dogmatic statements upon subjects on which even his extensive but specialized experience can hardly support an authoritative opinion. It is, in fact, impossible to apply the ordinary standards of criticism to this work, since it forms, not so much a text-book, as a résumé of the theories adopted by one school of thought. Much of the subject matter of the book has appeared in article form in various medical journals since 1911; and the impression is forced upon the reader conversant with these publications that Dr. Jordan has learnt but little from the great radiological experience which he has undoubtedly enjoyed during the intervening years. In nearly every chapter which deals with the radiological aspect of his subject will be found early observations on the normal and abnormal appearances which are of the greatest interest and value; but these are generally followed by deductions to which the later experience of other workers lends but little support. A particularly unfortunate chapter is that on the pelvic colon: the author here enumerates cases of disseminated sclerosis, epilepsy, fibroid phthisis, Dupuytren's contraction, etc., in which elongation of the pelvic colon was present; and the reader is invited to accept as a fact that the colonic abnormality provides the causal factor in the production of these lesions, no attempt whatsoever being made to advance proofs of these startling assertions.

A chapter on the treatment of stasis is of considerable interest. The author lays great stress on the value of the Curtis belt, combined with the administration of liquid paraffin, belladonna, and colloidal kaolin, and emphasizes the importance of correct diet. He considers that surgical intervention is only required for rectifying the secondary consequences of stasis, and in those cases where the large bowel is diseased beyond repair.

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**Selections from the Works of Ambroise Paré: With Short Biography and Notes.** By DOROTHEA WALEY SINGER. Crown 8vo. Pp. 246, illustrated. Medical Classics Series. 1924. London: John Bale, Sons & Danielsson Ltd. 12s. 6d. net.

ALL lovers of the classics of medicine have every reason to be thankful to Mrs. Singer. She has added a very delightful book on Ambroise Paré to the series of Classics of Medicine edited by her distinguished husband. Of course, classics of medicine may be dull, just as all classics may be dull; but Paré is of unfailing

interest. His life and his work and his character will always attract the minds and the hearts of good judges of mankind. He lived in times which were full of passion and adventure; he was surgeon to four Kings of France, and to a host of the nobility, and gentry, and poor folk: his adventures in practice, especially in military service, and his discoveries and theories, will never be dull. Besides, his pleasant character, his humour, his love of his country, his enjoyment of the evident privileges of his existence, from good wine up to religion, stand out as clearly as any of his adventures and theories. Altogether he was a most lovable man.

It must have been hard work for Mrs. Singer to resist the temptation to rhapsodize over him: but she has done well to give more attention to his writings than to his home life, his services to the Royal Family and the Court, and so forth. He attended each of that brood of sons whom Catherine de Medici bore to Henri II, and he "held his cup straight", Huguenot though he was, through all the intricacies of that Court. Mrs. Singer wisely says that the question of Paré's religion never has been, and probably never can be, entirely decided: "for the truth is that he was neither fully Catholic nor fully Huguenot, but a devout and simple-hearted lover of God and man, who went his way and did his work according to such light as was given him, avoiding, as far as was possible, in those evil days, all the hatreds and envies that the name of religion inspired".

Only two criticisms of this book are possible. Mrs. Singer has kept the old-world spelling of Johnson's translation of Paré's works: perhaps she has done well; but it is hard to see why we have modernized Shakespeare if we are to be held down to the Elizabethan spelling of Johnson. The only other criticism is in regret that she has not used the portrait of Paré which Le Paulmier published in his *Life of Paré*. It is a charming portrait. Anyhow, here is a good book, worthy of buying and studying. It is a great pity that the old Harveian and Hunterian Orations are tied down to the pious commemoration of two men and no more. Long ago the original spirit of these Orations flickered out. The authorities ought to arrange for the praising of famous men in order of time. Ambroise Paré, most certainly, ought to be recalled to the gratitude of all our profession, and of all men who love a good life well lived. Meanwhile, let us congratulate Mrs. Singer on this excellent book about him.

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**The Treatment of Fractures in General Practice.** By C. MAX PAGE, D.S.O., M.S., F.R.C.S., Senior Surgeon to Out-patients, St. Thomas's Hospital, and W. ROWLEY BRISTOW, M.B., B.S., F.R.C.S., Surgeon to the Orthopædic Department, St. Thomas's Hospital. Demy 8vo. Pp. 239 + xi, illustrated. 1923. London: Oxford Medical Publications. 12s. 6d. net.

This handbook sets out to assist the general practitioner in the treatment of fractures, and in our opinion fulfils its object. The chapters dealing with general principles of treatment are clear, and in most cases give sufficient detail to be of practical value. A book emanating from St. Thomas's Hospital is certain to advocate the employment of plaster-of-Paris more generally than would be the custom of many surgeons, but even those who do not favour the use of plaster could take no great exception to its employment as advocated in this volume. In this connection we doubt whether the single plaster-of-Paris spica as depicted on page 150 would maintain abduction of the limb, as in our experience tilting of the pelvis will occur unless both thighs are held in plaster. In some instances it is our opinion that the authors are sanguine as to the results likely to be obtained from splint treatment. As an instance, the advice given for the treatment of fractures of the upper third of the femur will serve: it has not been our experience that such fractures can be adequately reduced by such methods as are here advised, or by immobilization in a Thomas's splint. We hold that it is important that the practitioner should be warned that, in such positions as these, splint treatment of a fracture is likely to be unsatisfactory, and that operative treatment should at least be considered without undue delay. We are glad to note that in dealing with



fractures of the lower end of the humerus the authors point out that the so-called 'separated epiphysis' is usually a fracture; but surely the same lesion is referred to on page 58 as a separation of the epiphysis. Is it correct to state that in fracture of the neck of the scapula there is lengthening of the arm? We have found this statement in other books as well as the one under review, but to us it has appeared impossible. Again, we find that fracture of the surgical neck of the humerus is a common accident; yet we have come to believe that the common fracture occurs considerably above the level of the surgical neck, and our opinion is confirmed by the photograph of the X ray which is intended to exemplify a fracture of the surgical neck. We should have liked to see greater stress laid upon the importance of rest and general treatment in fracture of the base of the skull, and consider the space given to fractures of the lower jaw scarcely adequate.

The diagrams are good, and the reproductions of X-ray photographs unusually clear, while the general finish of the volume is in keeping with the good level of the Oxford Medical Publications.

**Surgical Emergencies.** By RUSSELL HOWARD, C.B.E., M.S., F.R.C.S., Surgeon, London Hospital; Senior Surgeon, Poplar Hospital. Crown 8vo. Pp. 216 + viii, illustrated. 1924. London: Edward Arnold. 7s. 6d. net.

MR. RUSSELL HOWARD has undertaken a very difficult and exacting task in setting forth in the limited space of 200 pages "the methods of arriving at a diagnosis and the details of the operation to be performed in all the surgical emergencies with which a surgeon is likely to be confronted". He has covered a very wide field, and as a record of many years of experience in emergency surgery the book is of considerable value. It would appear, however, to be well-nigh impossible to include the many small but all-important technical details necessary for the guidance and safety of his junior colleagues, although he has attempted to do this in so far as the space at his disposal would permit.

The book commences with concise practical directions for dealing with hæmorrhage, and passes on to the consideration of shock. The treatment of shock leaves a good deal to be desired, and the views expressed on its pathology do not accord with the doctrines of modern physiology. Wounds of the limbs are dealt with in detail, and the next five chapters are devoted to acute abdominal lesions, intestinal obstruction, and the after-treatment of abdominal operations. This is the best section of the book, and great stress is laid upon the importance of rest and sleep and all measures to obtain these, as opposed to stimulant treatment, in the management of post-operative abdominal cases.

The final chapters deal with emergency conditions met with in the surgery of the urethra, of the head, of the neck, and of the thorax and spine, the last chapter giving a brief account of the most important lesions of the ear and eye likely to call for immediate operation.

There are several points which call for criticism. Some of the operations described—for example, the more elaborate methods of treating fractures, and the radical mastoid operation—can scarcely be considered as emergencies. Some of the measures suggested—for instance, excision of a gastric ulcer as an alternative to suture after acute perforation—though safe in the hands of the author, might be dangerous if attempted by his junior colleagues. The illustrations are poor on the whole, and some of them are distinctly misleading, and do not illustrate what is described in the text. The picture of suprapubic puncture shows the cannula inserted midway between the pubes and the umbilicus; and the picture of sub-temporal decompression shows a left-sided bone defect which, if the operation were carried out as illustrated, would lead to a disastrous result. These minor mistakes, of which there are many in the book, coming from the pen of so well known a surgeon and teacher as Mr. Russell Howard, must not be allowed to pass without comment.

**Radium, X Rays, and the Living Cells:** with Physical Introduction. By HECTOR A. COLWELL, M.B. (Lond.), D.P.H. (Oxford), Assistant Radiologist, King's College Hospital; and SIDNEY RUSS, D.Sc. (Lond.), F.Inst.P., Joel Professor of Physics, Middlesex Hospital Medical School. Revised and enlarged edition. 1924. London: G. Bell & Sons Ltd. 21s. net.

THE authors of this text-book, which first appeared in 1915, rendered pioneer service to the subject of 'radio-biology' in producing it. It is always a difficult task to catch the first early outlines of a nascent science and to fix them in the framework of a text-book. That the attempt was successful is shown by the present revised and enlarged edition. The appearance of this work was significant in another aspect. It was one of the earliest products of close co-operation with a common aim between a medical man and a pure scientist. It seems likely that the future advance of medicine will increasingly depend upon such partnerships.

It is hardly necessary to enter into a detailed criticism of this well-known work. It opens with a physical section, doubtless contributed by Professor Russ, in which the fundamental facts about radium and X rays are stated authoritatively in a form intelligible to the non-physicist. In the later portions of the book the present state of our knowledge in regard to the effects of radiation upon living tissues, and especially upon neoplastic tissues, is fully set forth.

In the present edition the scope of several chapters has been extended to include recent experimental results, and a new chapter summarizes the action of radiation on living structures, and discusses the theories put forward to account for the observed results. A practical chapter upon the precautions to be taken by those habitually exposed to radiation might usefully have been added. In discussing secondary X rays the authors say, "Now that some of the fundamental properties of secondary X rays are known, it is highly probable that efforts may be directed towards their use". It seems strange that they do not mention the method of bismuth injection preparatory to X-radiation which was employed in the treatment of malignant disease, not without success, until the discovery of radium superseded it. The value of *Plate II*, an X-ray photograph by means of a crystal of zinc blende, would have been enhanced by a fuller description.

Apart from these criticisms on points of detail, we have nothing but praise for the book. It is indispensable to all surgeons interested in the therapeutic uses of radiation.

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**Collected Papers of the Mayo Clinic.** Vol. XIII, 1921. Edited by Mrs. M. H. MELLISH. Pp. 1318, illustrated. London and Philadelphia: W. B. Saunders Co. Ltd. 60s. net.

THOUGH the personnel of the Mayo Clinic has considerably increased since their new offices were completed, it is nevertheless a matter for congratulation that not only the volume but also the quality of the literature put out from the clinic maintains the high level of the early publications. We are glad to note that Dr. William Mayo looms more largely in this volume than in the last. Since the war the character of his papers has undergone some change. We have here, it is true, two of purely clinical interest on the surgery of the spleen, but that on hepatic insufficiency breaks new ground, and as it is now realized that comprehension of the functions of vital organs is necessary if we are to understand their pathology when involved in disease, there can be no doubt that these papers will be often referred to. This paper, the second Murphy Oration, details many interesting facts in the career of that brilliant surgeon, and it is in this appreciation of the works of others, as is also seen in that of Henry Jacob Bigelow, read before the Boston Surgical Society, that the generosity of thought that pervades all his writings is most apparent. Dr. Mayo has recently broken out in another direction, for his address on "The Medical Profession and the Public" shows how one who has made a world-wide reputation as a surgeon may also develop valuable qualities as a publicist. The Mayo Clinic have placed the wealth of their experience without stint

at the service of the world ; surgeons in other countries with one per cent of the cases seen in the clinic have for their instruction details of the practice, both in preparation, operation, and after-treatment, which can save them from many difficulties and possibly fatalities ; thus Waltman Walters' paper "On the Preparation of Patients with Obstructive Jaundice" is typical of one of the most valuable results of so large an operative and collated experience.

The more purely scientific papers range over so wide a field that it is scarcely possible for anyone interested in any aspect of medicine to open the volume without finding something which it will profit him to read. The investigations by Georgine Luden on "Blood Cholesterol" open out a most important field in the relation of this substance to cancer research. There is no doubt that a very large amount of experimental work is summarized in Williamson and Mann's "Experimental Study of Post-operative Peritoneal Adhesions". It should help others experimenting in this field, for they have convinced themselves that all the substances hitherto employed have been useless in preventing adhesions ; and in recommending a gum-acacia-gelatin mixture as affording the best chance of preventing adhesions, they acknowledge certain difficulties in its use which they have not been able to overcome. Finally, we would like to draw attention to Rosenow's Mayo Foundation Lecture on "Focal Infection", which is remarkably stimulating in idea, and if pursued to its obvious ends in the clinical field may have very far-reaching consequences.

**Excursions into Surgical Subjects.** By JOHN B. DEEVER, M.D., Sc.D., LL.D., F.A.C.S., Emeritus Professor of Surgery, University of Pennsylvania ; and STANLEY P. REIMANN, M.D., Assistant Professor of Experimental Pathology, University of Pennsylvania. 8vo. Pp. 188, illustrated. 1923. London and Philadelphia : W. B. Saunders Co. Ltd. 21s. net.

DR. DEEVER is one of the most versatile and prolific of authors, and one of the most expert of living surgeons. When vast experience is combined with sane judgement, with an acute sense of the fitness and the worth of things, and with a gift of frank and lucid expression, a man's influence becomes world-wide. There are few surgeons who equal Dr. Deever in any of these attributes. Everything he writes is deserving of our serious attention.

This little book contains a series of papers written during the last few years, and several lectures delivered at Washington University. It is convenient to have them bound together for easy reference. Throughout all the chapters we find freshness of experience rather than originality of thought. There is no intellectual challenge ; no provocation comes from the statement of new truths ; but a delight is roused within us when we listen to a clear and candid examination of the old truths newly illustrated.

The lecture upon jaundice contains an interesting summary of the views held with regard to this symptom by the French writers and others. Chauffard's name, on page 60, appears twice as Chaufford. Few surgeons will agree with Dr. Deever when he asserts (p. 61) that Hanot's cirrhosis is possibly the final stage of Banti's disease. W. J. Mayo doubts the existence of Hanot's cirrhosis. It is more than probable that Hanot described both biliary cirrhosis and hæmolytic jaundice under the one heading. The term Banti's disease is better reserved for the final stage of splenic anæmia. It has no connection, even of the remotest kind, with Hanot's cirrhosis, however we may interpret that disease.

In the lecture on diseases of the gall-bladder a classification of cases is introduced which appears to us to be strained and artificial. The preference for removal of the gall-bladder rather than its drainage will have the support of all surgeons to-day. The "Trials, Tribulations, Joys of a Surgeon" make a very interesting lecture.

The final chapter is headed "Living Pathology". Throughout the volume a reference here and there is made to 'living pathology'. The phrase 'the pathology

of the living' was introduced into surgery many years ago by Moynihan. The thought that he desired to illustrate is not indicated by a change of his phrase into 'living pathology'. Pathology is not a state of the tissues, but is a science; and the term 'living pathology', if it means anything, surely signifies that this science is vital, active, and growing. That is not what Dr. Deaver intends, however true it may be. His meaning is Moynihan's meaning.

Dr. Stanley Reimann contributes a few sections to the book, all of them of interest and value.

*La Pratique Chirurgicale Illustrée.* By VICTOR PAUCHET. Fascicule IV. Octavo. Pp. 250, with 307 illustrations. 1923. Paris: Librairie Octave Doin. 25 francs net.

THIS is the fourth portion of an Illustrated Practical Surgery, the previous portions of which have been reviewed in this JOURNAL.

The present volume deals with the surgery of the breast, duodenal ulcers, biliary passages, appendix, some diseases of the rectum, and some operations upon the uterus and appendages. The book is characterized by most profuse illustrations depicting the various stages of different operations. These illustrations are very good, and no doubt will be useful to many.

*Die Chirurgie des Anfängers.* By DR. GEORG AXHAUSEN, Professor of Surgery in the University of Berlin. 1923. Berlin: Julius Springer. 4.50 dollars.

THE best form of preliminary instruction in medicine and surgery is one of the questions which is giving rise to much thought in medical schools to-day. It is frankly admitted that our present methods are not satisfactory, and in consequence it is of interest to look and see what is being done in other countries. Professor Axhausen has written a book of 440 pages, well bound and illustrated. It comprises three chapters—on general surgical principles, methods of examination of special parts, and the principles of operative surgery. The book is good of its kind, but it does not yet satisfy the wants of the student who wishes to learn medicine as a science and not as a craft.

*Chirurgie de la Tête et du Cou.* By CH. LENORMANT and P. BROCCQ. Sixth edition. Crown 8vo. Pp. 338 + viii, with 245 illustrations. 1923. Paris: Masson et Cie.

THIS book, one of a series of seven volumes entitled "Précis de Technique Opératoire", has reached its sixth edition, the first having appeared in 1904. It embraces a surprising medley of operations, ranging from removal of the Gasserian ganglion to the extraction of a wisdom tooth. The steps of each operation are briefly related, and are illustrated, in many instances remarkably well, by a large number of semi-diagrammatic pictures.

For a student wishing to refresh his memory before an examination, the little book should prove valuable, but one can scarcely agree with the opinion expressed in the preface that every practitioner ought to know how to carry out these operations, "since the practice of surgery is no longer confined, as formerly, to the hands of a chosen few". There would not be many who would care to entrust to the average doctor such procedures as hypophysectomy, laryngectomy, or excision of the cervical sympathetic, nor would many general practitioners be prepared to carry out the removal of a cerebellar tumour through an osteoplastic craniotomy. On the other hand, the accounts of such operations as tracheotomy, mastoid antrotomy, and the like, clearly described and well illustrated as they are, give the book a reasonable claim to a place in the general practitioner's library.

**Les Ulcères de l'Estomac et du Duodénum.** By ED. ENRIQUEZ and GASTON DURAND.  
Crown 8vo. Pp. 184, illustrated. 1923. Paris: Masson et Cie. 10 francs net.

THIS small volume concerns itself with diagnosis. After a brief historical account, the book is divided into two parts: (1) Diagnosis of the lesion; (2) Diagnosis of the seat of the ulcer. It is a book of value in that it gives the views of our French colleagues on diagnosis and methods of examination.

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**Traumatismes du Poignet et Rayons X.** By ETIENNE DESTOT, Lyon. Royal 8vo.  
Pp. 174, with 184 figures. 1923. Paris: Masson et Cie. 16 francs net.

THIS is the posthumous work of Destot, which was finished by him, but not published, in 1918, a little before his death. In this book attention is called to the injuries of the wrist which previously were little known or studied, and the matter is dealt with altogether in an admirable style. The only criticism is with the printing of the skiagrams. These are generally useless, owing to the inferior quality of the paper and the method of reproduction, which completely spoil a good monograph.

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## *EPONYMS.*

BY SIR D'ARCY POWER, K.B.E., LONDON.

### **XIV. WHEELHOUSE'S OPERATION.**

GONORRHOEA is a very old disease ; from time to time our arboreal progenitors must have ruptured their urethras by carelessly falling astride of a branch ; and the numerous operations for stone in the bladder in later days was followed by stricture of the urethra in a certain proportion of cases. Retention of urine is a troublesome condition, and its treatment is often urgent. The historical medical museums at Naples and in London show that catheters were an early invention, but surgical literature proves that the morbid anatomy of stricture was ill-understood. Galen seems to have thought that it was due to ulceration of the bladder ; later opinion placed the seat of ulceration at the neck of the bladder or in the prostatic portion of the urethra, and throughout the middle ages retention of urine was stated to be caused by 'polypi' or 'caruncles' in the urethral canal ; only lately has the real pathology of stricture been correctly explained. The treatment of the slighter forms of stricture has never presented much difficulty, but impervious strictures were a real bugbear to the older surgeons. Some confessed frankly that nothing could be done, and left the patient to Nature, hoping that the urine would become extravasated ; others, bolder, used caustics of lime or arsenic to destroy the 'caruncles' ; a few, like Ambroise Paré and Amussat, devised cutting probes with which they performed internal urethrotomy.

Astruc, who wrote a most useful and instructive history of venereal disease, says in 1736, after discussing the causes and treatment of urethral stricture, "But if no sort of catheter can be introduced there is only one method left of preserving the patient : to wit, to pass a trocar through the wound in the perineum directly into the bladder according to the known direction of the urethra, and by this means draw off the urine. We do not deny that the instrument in this operation deviates from the natural duct of the urethra, and wounds its coats in passing into the bladder. But what then ? In the present danger of death it is better to try a doubtful remedy than none : neither are wounds of the urethra of such a nature that they will not admit of a cure. But as in former cases so in this, a pipe must

be kept in the bladder till there is a free passage through the urethra and the tone of the bladder is perfectly restored; and lastly, the pipe being drawn out, the wounds of the urethra are to be cleansed, carnified, and cicatrized according to the rules of our art." Astruc's treatment was followed for many years, though it was modified by Edward Cock, surgeon to Guy's Hospital, who published in 1852, in the *Transactions* of the Medical and Chirurgical Society, his paper on forty cases of retention of urine in which the bladder was punctured through the rectum.

In 1844 Professor Syme, of Edinburgh, published an account of his method of treating obstinate strictures of the urethra by external urethrotomy. He passed a small grooved director not exceeding in size the largest knitting-needle which could be passed through the stricture; cut down upon it through the perineum, and thus divided the stricture. The disadvantage of Syme's operation lay in the fact that it was unsuitable for impermeable strictures, as a filiform staff had first to be passed; but it was largely used for many years.

Mr. Claudius Galen Wheelhouse published part of a clinical lecture in the *British Medical Journal* for Feb. 5, 1870. The lecture was given in the Leeds School of Medicine upon two patients with impermeable stricture of the urethra, and in it he pointed out the advantage of using a grooved lithotomy staff rather than a sound or catheter in performing external urethrotomy. He also laid stress upon the advisability of opening the healthy urethra in front of the stricture, instead of cutting down upon the stricture itself as was done by Syme. He then went on to say: "I next seize with artery forceps each lip of the opening I have made into the urethra, and with these draw upon the canal, carefully assuring myself that the mucous membrane is included. The position of the staff is next completely altered. Taking it in my own hand, I reverse it, turn the point out through the opening I have made, and use it to draw forward, fix, and steady the urethra. If the parts are now carefully sponged, I have the interior of the canal so fully exposed to view that I can steadily follow its upper wall; this I do with a fine probe-director until I have cut my way completely through the stricture, and have come out into the dilated part of the urethra, which usually lies behind it, or, as sometimes happens, into a second or more strictures; this effected, I am generally able to pass the small director which I have been using immediately onwards into the bladder. Now, at this point I have seen the most skillful operators completely baffled; and although they have succeeded in effecting the division of the stricture most perfectly, I have known them fail entirely in their attempts to carry the catheter onwards into the bladder. Without a guide it is often a most perplexing and difficult matter to find the opening into the posterior portion of the urethra, or, when this is found, to insinuate the catheter into it by the side of the director; and it is precisely at this point that my little grooved director becomes of all important service. Having reached the bladder with that, I turn the groove downwards; with a straight probe-pointed bistoury run along it, I make sure of the division of any further obstructing bands, and finally I completely open up the prostatic urethra by sliding along the groove of the director the little instrument which I now show you, the 'probe-dilator', an instrument introduced by the late Mr. Teale



CLAUDIUS GALEN WHEELHOUSE





(1801–1867) for use in lithotomy, and thus obtain a broad metallic floor upon which I can, without any danger of failure, introduce a catheter of even the largest size.”

It will be seen that this lecture contains the essence of an operation which Mr. Wheelhouse afterwards standardized, and which has since come into very general use.

It was some years before the advantages of the operation were recognized. Writing to the *British Medical Journal* on June 24, 1876, Mr. Wheelhouse says: “Notwithstanding the length of time that has elapsed since I brought



FIG. 151.

before the profession my method of finding my way in cases of impermeable stricture from the perineum, *through* the stricture and into the bladder, the subject seems to have received so little notice that I deem it advisable once more, after several years of successful employment of the

operation, to revert to the subject. The instruments required are as follows: lithotomy bandages; a special staff fully grooved through the greater part, but not through the whole of its extent, the last half-inch of the groove being ‘stopped’, and terminating in a rounded button-like end (Fig. 151); an ordinary scalpel; two pairs of straight-bladed forceps, nibbed at the points: ordinary artery forceps and ligatures; sponge; a well-grooved and finely probe-pointed director; Teale’s probe-gorget (Fig. 152);\* a straight probe-pointed bistoury; a short silver catheter (No. 10 or 11 gauge) with elastic tube attached.” The details of the operation are then given, and they do not differ materially from those previously described, though it may be noticed that as a result of further experience Mr. Wheelhouse had replaced the lithotomy staff which he used originally by a specially designed straight staff, and the curved by a straight catheter.

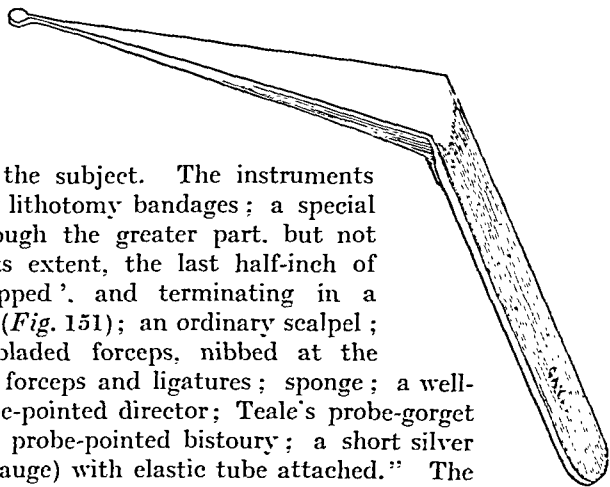


FIG. 152.

Claudius Galen Wheelhouse was born at Snaith, in Yorkshire, on Dec. 29, 1826, and died at Filey on April 9, 1909. He was the second son of James Wheelhouse, a surgeon, and was educated at the Bluecoat School in London. He was apprenticed at the age of sixteen to R. C. Ward, of Ollerton, Newark, and entered the Leeds School of Medicine in October, 1846. He qualified M.R.C.S.Eng. in 1849, and L.S.A. in the following year. He then went to the Mediterranean on a yachting cruise as surgeon to Lord Lincoln, afterwards fifth Duke of Newcastle and Secretary of State for War. He took with

\* Figures 151, 152 are reproduced from the *British Medical Journal*, June 14, 1876.

him one of the first photographic cameras which left England, and obtained many good photographs in spite of the cumbrous processes then in use.

Returning to England in 1851 he entered into partnership with Joseph Prince Garlick, of Park Row, Leeds, the senior surgeon to the dispensary and lecturer on surgery at the Leeds School of Medicine. In the same year he was elected surgeon to the Public Dispensary and demonstrator of anatomy in the Medical School, where he was successively lecturer on anatomy, physiology, and surgery. He was twice President of the School, and when the new University of Leeds was inaugurated in October, 1904, Wheelhouse was made an honorary D.Sc. He served on the Council of the Royal College of Surgeons of England from 1876 to 1881, and presided at the Leeds meeting of the British Medical Association in 1889. He was also an elected representative of the medical profession upon the General Medical Council from 1886 until 1896.

The portrait is from a photograph kindly lent by S. F. Cowell, Esq., M.A., Secretary of the Royal College of Surgeons of England.

## THE SECTIONAL PLASTER-OF-PARIS CASING WITH REFERENCE TO THE TREATMENT OF FRACTURES OF THE LEG AND ANKLE: CASE REPORT.

By W. A. COCHRANE, EDINBURGH.

THE criterion of function as the standard for judging the end-results of fractures is of great significance with regard to those of the leg, ankle, and foot. The deliberations of such bodies as the Fracture Committee of the British Medical Association in 1914 emphasize its importance especially in respect of the restoration of anatomic alinement. The Committee concludes that no method of treatment should be adopted which does not secure restoration and maintenance of anatomic alinement. Consideration of fractures in the region of the ankle demonstrates that in them, as in all articular and para-articular fractures, the effect of the injury upon the neighbouring joint is of greater importance functionally than the effect upon the bone itself. Restoration of anatomic alinement is necessary if the axes of the joint are to be correct as to their line of action and to the proper functioning of the tendons acting on and over it. P. D. Wilson, of Boston, has formulated the following rules as fundamental in the treatment of fractures of the ankle and of the bones of the leg:—

1. Complete anatomic reposition should be the goal in all cases, but slight displacement is not incompatible with good function, provided that the axes of the main fragments of the tibia remain parallel, and the tibio-astragaloid joint lies in the normal horizontal plane. In general, angular deformity is more to be feared than any other type of displacement.

2. When rigid dressings are necessary, care should be taken to fix the foot and ankle in the position of optimum function, that is, with the ankle at right-angle flexion, the foot inverted, and the arches supported.

3. The fundamental supporting structures of the foot being muscular,



FIG. 153.—Antero-posterior skiagram of fracture-dislocation of the ankle. The foot and the malleoli have been displaced medially in relation to the bones of the leg.

it is of the utmost importance to preserve their tone and strength by beginning massage and active movement at as early a date as possible.

4. When weight-bearing is first permitted, the foot being weak, a certain amount of support should be provided by the use of a heel whose inner border is elevated. This slightly inverts the foot and holds it in a position of strength. Unprotected weight-bearing should not be permitted until the muscular function is good.

A large majority of fractures of the bones of the leg, and nearly all frac-



FIG. 154.—Lateral skiagram of the same: it shows the posterior dislocation of the ankle, and the fact that the malleoli are also displaced backwards.

tures and fracture-dislocations of the ankle, may be successfully treated by immediate reduction of the displacement under an anæsthetic, followed by immobilization in a plaster-of-Paris casing. With regard to fractures of the bones of the leg, simple fractures with displacement which are more or less transverse and are uncomminuted, come into this category. In those which are compound, comminuted, and are oblique or spiral in direction, traction methods or operation are best. It is the first group that is considered in this communication. The casing may be bivalved at once, and massage begun on the foot and leg as they lie in the posterior section of the casing. In a large series of cases, observed or treated by the writer, no interference with the circulation has taken place; although, in point

of fact, the bivalving of the casing would help to prevent it. Nor has it been his experience that these fractures are usually associated with swelling, such as the books describe, sufficient to contra-indicate the use of plaster-of-Paris. It is fears such as these, which have no foundation in fact when the plaster is carefully applied, that, in the writer's opinion, have militated against the more general employment of the very best retention means at our disposal in certain fractures.

The main difficulty in fractures of the leg and ankle lies, however, not in the actual reduction of the displacement, provided an anæsthetic is employed, but in the maintenance of the corrected position while immobilization, whether by splint or by plaster, is being secured. The ordinary means of splintage, as in the use of the box-splint or in the special splints which have been devised from time to time, are too haphazard in this respect. While one of these means is being employed, the fracture *redisplaces*, or does so subsequent to the patient's return to bed. All the work of reduction and the risk of the anæsthetic go for nothing, and the patient is in the unfortunate position of having to subject himself to another attempt at reduction, with the certainty of the same thing happening again. "But", someone will say, "such a case should be treated by other means, by operation, say, or by traction in a Thomas's splint". Such a reply, in the writer's opinion, simply begs the whole question of the possibility of treating the large group of cases referred to by the reduction and fixation method. Further, there is no question, in the case reported here, that treatment by operation or by traction could not have fulfilled the demands of the case.

It is with the main object of demonstrating that a precise, simple, and eminently practical method is available for such cases as are difficult to hold while fixation is being applied, that this communication is made. It involves the employment of a plaster-of-Paris casing applied in sections.

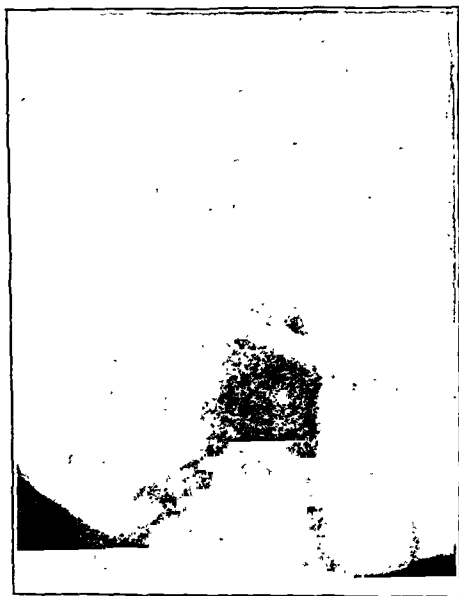


FIG. 155.—Over-correction of the mesial displacement of foot and malleoli.

### CASE REPORT.

The following case, a fracture-dislocation of the ankle, is therefore reported at this time, as being of special clinical interest and importance with reference to the success which attended the use of a special method—a plaster-of-Paris casing applied in sections—in securing and maintaining reduction in a difficult class of case which had resisted the methods of reduction and immobilization commonly employed.

The patient, a middle-aged adult, was admitted to hospital on Jan. 16, 1924, with a simple fracture-dislocation of the right ankle, sustained in a street accident. She was knocked down by a motor cycle, the foot being caught and twisted by the machine. Clinically, there was present gross backward and inward displacement of the foot in relation to the leg. There was very little swelling. The antero-posterior skiagram (Fig. 153) revealed a fracture

through the base of both malleoli, with mesial displacement of the foot and malleoli. The lateral skiagram (*Fig. 154*) showed a complete posterior dislocation of the ankle, with posterior displacement of the malleoli.

Under the anæsthetic, reduction in both planes was obtained without much difficulty. The fact that the bony points about the foot and ankle were restored to the normal, and that the foot could be dorsiflexed beyond the right angle, was proof of this. As soon as support was altered or removed in the slightest degree, however, it was evident that the posterior dislocation



FIG. 156.—Profile view taken through plaster casing shows that the posterior dislocation has not been reduced.

recurred with the greatest ease. The extensive tearing of the ligaments was responsible in part, but a factor of greater importance, doubtless, lay in the loss of support to the astragalus normally provided by the malleoli when intact. Reduction being effected once more, the limb was encased in plaster-of-Paris from the toes to the middle of the thigh, with the knee flexed 30 degrees. Every effort was made to prevent recurrence of the dislocation while this was being done. The subsequent skiagrams (*Figs. 155 and 156*) showed, however, that while the displacement mesially had been over-corrected, the posterior dislocation was still unreduced. What had happened was that, in

making way for the turns of the plaster bandage, a momentary slackening of the hold, or an alteration in the position of the surgeon's hands, had allowed the corrected position to be lost, and that in spite of one's appreciation of its imminence. The writer felt that he was not justified in subjecting the patient to a second attempt at reduction unless a method or device more accurate and precise was available. It was desirable that a method should be adopted which would guarantee that, having secured reduction, it would not be lost again by the surgeon's hands requiring to alter their position, even momentarily, while immobilization was being secured in a plaster-of-Paris casing. As has been pointed out above, that is the crux of the whole question in such cases.

### The Three-piece Sectional Plaster-of-Paris Casing.

A little thought suggested the idea that such a method was available and practicable, if the principles underlying the employment of a plaster-of-Paris casing, put on in two or more sections, as is done in orthopaedic surgery, could be adapted to the fracture-dislocation in question. It was evident, then, that if separate plaster casings were applied, and allowed to set, above and below the area involved—in this case the ankle—so leaving it free for manipulation, the surgeon could correct the dislocation vigorously, and his assistant unite the two plasters by a third plaster bandage. The surgeon's hands would be out of the way of the turns of the third bandage as they were being applied, and therefore there would be no question of his hands requiring to alter their force or position meanwhile.

The first casing was removed. All swelling had subsided. An anæsthetic was administered, and over stockinette and woollen bandages the first section of the plaster was applied from a point two finger-breadths above the level

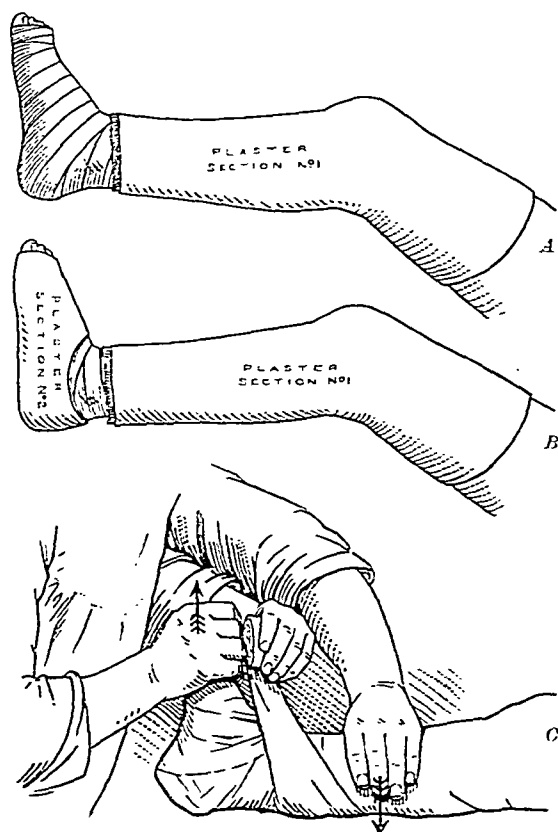


FIG. 157.—Illustrating the three-piece sectional plaster-of-Paris casing. A, Drawing from a photograph, showing the first section of the plaster casing applied. Note the projecting edge of the cuff of felt referred to in the text. B, Nos. 1 and 2 sections of the sectional plaster, leaving the region of the ankle free. C, Drawing from a photograph to show how reduction of the posterior fracture-dislocation is effected. Note that the foot is fully dorsiflexed and slightly inverted.



of the ankle-joint to the mid-thigh. Care was taken to encircle the leg just above the ankle with a cuff of sterilized felt, 4 in. broad, to take the backward pressure to be borne by this part of the anterior aspect of the leg in reducing the dislocation. The knee was flexed 30 degrees to relax the calf muscles and so allow of free dorsiflexion of the foot in the final position (*Fig. 157, A*). The heel being protected with a square of white felt, a second section of the plaster encased the foot, and was moulded by the hands to support the arches. This left the ankle free of plaster and ready for manipulation (*Fig. 157, B*). The two sections were allowed to set, and then the edges were trimmed and everted to avoid risk of pressure by them upon

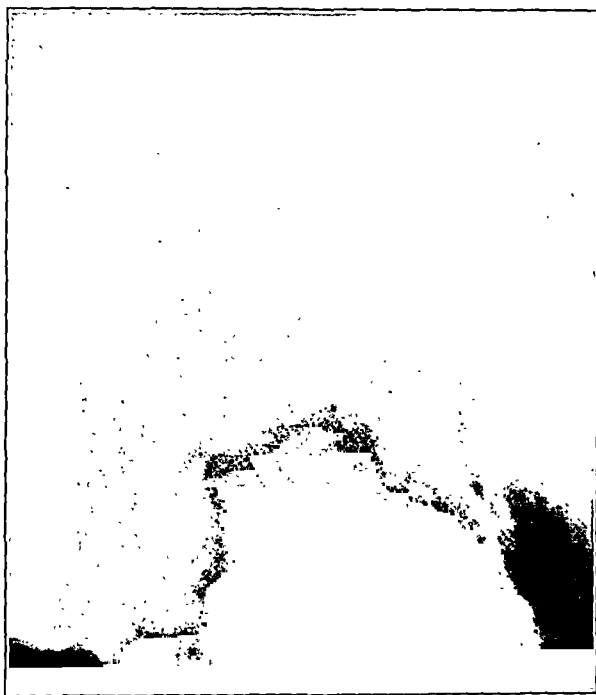


FIG. 158.—Antero-posterior view after treatment by sectional casing.

the soft parts in the final position of correction. The manipulation to secure reduction of the posterior dislocation was then made by pressing backwards with the flat of the left hand on the anterior aspect of the lower end of the first-applied cast, while the right hand seized the plaster encasing the foot and pulled it forwards vigorously (*Fig. 157, C*). Reduction was felt to take place quite easily, as before. The foot being fully dorsiflexed and in slight inversion, it was possible for the surgeon to maintain the reduction strongly and with absolute certainty, while an assistant united the two plasters by a few turns of a plaster bandage. In this way the third and last section was applied and the casing completed (*Fig. 157, C*). The whole point in the rationale of the scheme lay, then, in the fact that, once reduction was

effected, it was never again in jeopardy or exposed to the risk of redisplacement.

Subsequent skiagrams (*Figs. 158 and 159*) showed that reduction in both planes had been secured. The limb was immobilized in the original plaster for six weeks to allow the malleoli to unite and the torn ligaments to heal. On lifting the limb from the splint, the patient had immediate power of moving the foot and ankle to quite an appreciable degree, and with massage the range of active motion is steadily increasing. The final result promises well as to ultimate function.



FIG. 159.—Lateral view of same.

**The Three-piece Sectional Plaster of Fiske.**—The device detailed above really represents an adaptation of the method of Fiske, of Chicago, in his treatment of congenital club-foot by a three-piece plaster-of-Paris casing. It was from having used Fiske's technique in such cases that the idea occurred to the writer that it might be adapted as a practical solution of the problem presented. In the case of congenital club-foot, Fiske pointed out that the various deformities were best corrected slowly in a plaster casing applied in sections, over stockinette made to adhere to the leg and foot by Sinclair's glue. A plaster-of-Paris casing is applied to the foot itself below the malleoli, suitably protecting the bony points with tiny squares of white felt. As the plaster sets, the surgeon seats himself opposite the child, who

is seated on his mother's knee, and moulds it carefully to secure correction of the flexion of the toes, the adduction of the foot, and the mesial tilting of the os calcis. These three deformities are all located in the foot itself. There remain three deformities of the foot in relation to the leg, namely, equinus, inversion, and internal rotation. The second plaster is therefore applied to the leg from a point just below the knee to a point just proximal to the ankle-joint. When it has hardened, foot and leg are grasped, and the former is brought gently into a position of dorsiflexion, eversion, and external rotation. The assistant then joins the two plasters by a third, and so completes the casing. *Fig. 160* represents the end-result of a typical case after nine months' treatment and four successive plasters. The method does not require an anæsthetic, is not forcible, and functionally gives the best results possible.



**FIG. 160.**—Final result in a case of congenital club-foot treated by the three-piece sectional plaster technique of Fiske. Full voluntary over-correction is possible. A supplemental operation was necessary in this case.

### The Sectional Plaster in Fractures of the Bones of the Leg.

—The writer owes to his association with Dr. P. D. Wilson, of Boston, instruction in a method used extensively by the latter in the Fracture Service of the Massachusetts General Hospital, and which the writer has employed since (*Fig. 161*). The patient is anæsthetized and placed on his back on a firm table with the buttocks resting on the edge. The uninjured leg rests on a chair, while an assistant holds the fractured leg. The foot and ankle of the fractured leg are now encased in stockinette and woollen roller bandages. The foot and ankle are padded with an anklet of thick felt, and a piece of strong bandage, 10 feet long, is tied over the anklet as a

clove-hitch, leaving the ends long. The loose ends are knotted around the hips of the assistant, so that, by leaning backwards, he may exert traction on the leg, while his hands are left free to support the foot. The knee is flexed to a right angle, and a wide bandage is made to encircle the thigh just above the knee. The ends, left long, are held by an assistant, who stands at the head of the table and exerts counter-traction. By this means, and by manipulation of the fracture itself, the fracture is reduced and the position maintained by the traction. The plaster casing is then applied in two sections. The first section extends from the ankle to the groin, and, when it has hardened, the ankle-sling is removed. The foot and ankle are then encased in a separate plaster and united to the first section. The foot is dorsiflexed and slightly inverted. Care must be taken not to include the traction-bands in the cast. The bandage round the thigh may be withdrawn in time, by not including it completely in the first instance, after which the gap is rapidly covered in by the plaster, and the assistant supports the knee and thigh manually.

It is a safe rule in all these cases to see the patient on the same day as that on which the cast is applied, and on the next day also. If any doubt exists as to the integrity of the circulation, the cast and its lining may be bivalved. In a large series of cases, the writer has seen no difficulty from this source, nor any untoward local pressure effects by the plaster.

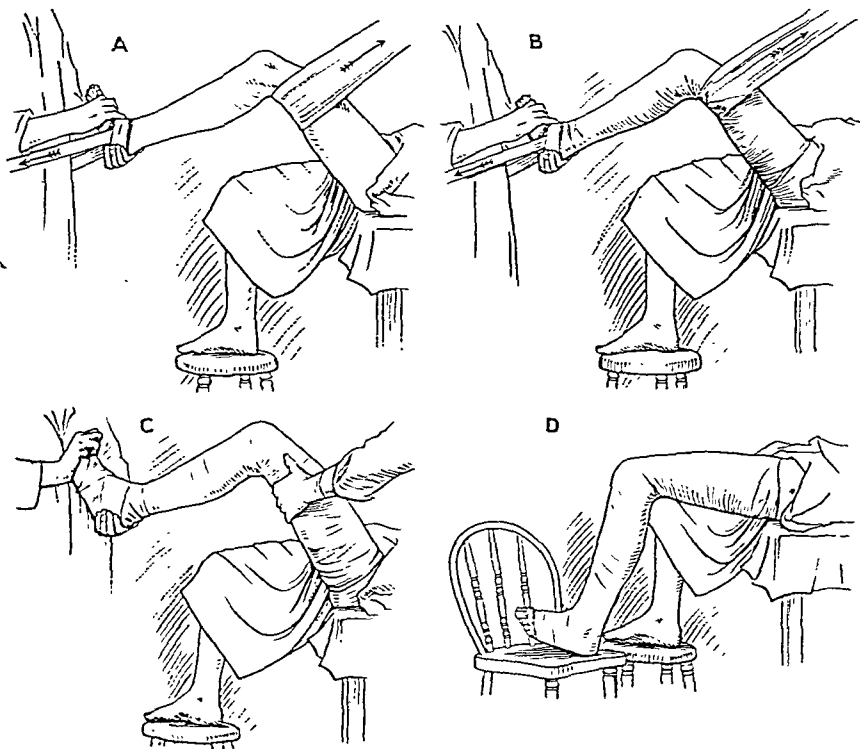


FIG. 161.—Reduction of a fracture of the leg by the traction method. A, Traction is obtained by passing a piece of bandage about the ankle in the form of a clove-hitch, a soft pad of felt being interposed between it and the skin. The ends of the bandage are knotted about the hips of an assistant, who supports the foot manually and exerts traction by inclining the body backwards. Counter-traction is obtained by a supporting hand passing around the lower part of the thigh which holds the knee flexed. B, In this position a plaster casing is applied in sections. The first section extends from the ankle to the groin, space being allowed for the removal of the counter-traction band. C, When this has hardened, the traction bands are removed and the foot is supported manually while the remaining portion of the plaster is applied. D, Plaster completed.

**The Process of 'Wedging' the Plaster Casing in the Correction of Residual Deformity.**—Subsequent skiagrams are taken through the plaster. As a rule, the position is satisfactory, but, should some angular deformity exist, it is possible to correct it by a process of 'wedging' (*Fig. 162*). Opposite the site of fracture, the case is cut in a circular manner for three-quarters or a little more of its circumference, leaving it intact opposite the obtuse angle of the angulation deformity. Using this intact portion as a hinge, it is possible to bend the cast in the appropriate manner necessary for the correction of the angulation. In doing so, the edges of the cleft in

the plaster are separated. To prevent their springing together again, little blocks of wood are put into the cleft, to maintain correction when the surgeon lets go his hold. The cast is then strengthened by a few turns of a plaster bandage. The principle of wedging is applicable to other fractures, notably in the forearm, as, indeed, is the principle of the sectional plaster.

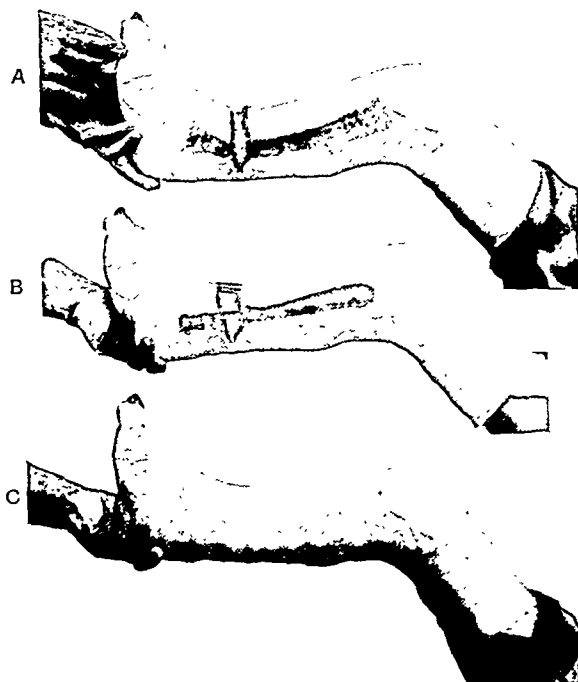


FIG. 162.—‘Wedging’ the plaster casing in correction of the residual deformity. A, The black line represents a fracture with posterior angulation. The cast has been cut in a circular fashion at the level of the fracture, leaving the casing intact posteriorly. B, The angulation has been corrected, and, to prevent recurrence of the angulation, little blocks of wood have been inserted to keep the edges of the cleft apart. C, A plaster bandage is then employed to cover in the whole, and the casing made complete again.

### CONCLUSIONS.

1. In fractures of the bones of the leg and in the region of the ankle, restoration to the anatomic normal is especially essential for function.
2. A large majority of these cases may be successfully treated by immediate reduction and fixation.
3. A general anæsthetic should always be employed.
4. A plaster-of-Paris casing furnishes the best means at our disposal for securing immobilization. In a large series of cases the writer has seen no untoward circulatory or pressure effects from its careful and proper employment. In his opinion, the splints in common use for these cases should be discarded.
5. Fractures of the bones of the leg and fracture-dislocations of the

ankle present their main difficulty, not in the actual reduction of the fracture, but in the maintenance of the corrected position while immobilization is being secured.

6. The ordinary means of securing immobilization are too haphazard in this respect.

7. A precise, accurate, simple, and practicable method, in the form of a plaster-of-Paris casing applied in two or more sections, is available. The device is based upon the three-piece sectional plaster method employed by Fiske in the treatment of congenital club-foot.

8. The process of 'wedging' makes very fine adjustments possible, especially with reference to angular deformity.

9. In the writer's opinion and experience, the sectional plaster-of-Paris method should be the method of choice in all cases with displacement, where immediate reduction and fixation are indicated.

10. In the especially difficult case, such as here reported, it becomes the method of necessity, for neither traction methods nor operation would have been likely to succeed.

The writer is indebted to Professor Sir Harold J. Stiles for permission to report this case.

**SQUAMOUS-CELLED CARCINOMA OF THE RENAL CALIX.**

By GEOFFREY KEYNES, LONDON.

MALIGNANT growths of any part of the renal pelvis are stated to be rare, and up to the year 1922 only the comparatively small number of 56 cases had been recorded in the medical literature of the world.<sup>1</sup> The total has now been increased to 60 or more, one of the additions having been made in a recent number of this journal by Mr. Geoffrey Hadfield,<sup>2</sup> who recorded most of the known facts relative to the condition. A considerable proportion of these tumours are found to be associated with calculi, but it is not as a rule possible to determine whether the carcinoma preceded or followed the formation of the calculus. It has usually been assumed that the carcinoma was consequent on the irritation caused by the calculus, but this assumption is not justified in view of the fact that many more malignant growths occur in the absence of calculi than with them. Very few of the recorded renal carcinomata were, on the other hand, associated with a hydronephrosis. Whether or not the carcinomata were preceded by leucoplakia of the epithelium of the pelvis or by chronic ulceration is in most instances difficult or impossible to determine. Only a very close examination of the case histories could throw any light on this point.

The purpose of the present article is to record two remarkable instances of renal carcinoma. The first, which was associated with calculus and pyonephrosis, presents several points of interest, both clinical and pathological. The second was associated with a hydronephrosis of the congenital type, and is chiefly of pathological interest. The records of a third case have been added to the series, since it illustrates in a striking manner the possible origin of a carcinoma in the pelvis of a hydronephrotic kidney, both leucoplakia and chronic ulceration being present.

CASE I.—A bookbinder, age 35, had enjoyed good health until the end of September, 1920. He then began to suffer from pain in the right side of his abdomen, associated with the presence of blood in his urine. The pain was not severe, and his general health had remained good. There was no increased frequency of micturition. An abdominal operation had been performed in infancy, but for what disease could not be ascertained. Hæmaturia had been noticed on one occasion six years before.

The patient was admitted to St. Bartholomew's Hospital on Oct. 18, 1920. He appeared to be thin and somewhat anæmic, but said that this was his normal appearance, and would not admit to having been ill for more than about three weeks. On examination he was found to have a large, fluctuating tumour in the right loin. Cystoscopy showed a normal bladder, but a purulent efflux was seen to come from the right ureter. X-ray plates showed the presence of a large branched calculus in the pelvis of the right kidney, and a diagnosis of 'pyonephrosis with calculus' was made. On

Oct. 26 a right nephrectomy was performed by Mr. T. P. Dunhill, a greatly enlarged kidney being removed through the usual incision in the flank. Some adhesions, thought to be inflammatory, were encountered at the lower pole, but no great significance was attached to these. The kidney, when split open, presented the appearance shown in *Fig. 163*. Each lobulation corresponded to a dilated calix containing pus, and five of the calices contained calculi. Another large calculus occupied the pelvis of the kidney, and possessed a short 'beak' projecting into the ureter. The calices at the lower pole contained some blood-clot as well as pus. The kidney tissue appeared to be



*FIG. 163.*—*Case 1.* Kidney split open along its free border, showing calculi in pelvis and calices. The white area in the wall of the calix near the lower pole on the right side shows carcinoma in section. A, Carcinomatous area.

almost non-existent, the organ having been converted into a multiloculated cyst with fibrous walls. The original diagnosis seemed to be confirmed, and the prognosis was regarded as being favourable.

The patient's convalescence was normal, and the discharge from the wound had ceased by Nov. 8, thirteen days after the operation. He was sent to a convalescent home soon afterwards.

On Dec. 7 the patient returned to his own home, and on the following day he noticed a recurrence of the tumour in the right side of his abdomen. He was re-admitted to hospital on Dec. 16, and was then found to have a large



fluctuating swelling in the same situation as before. There was a small mass of 'granulations' at one end of the operation wound, which was again discharging some purulent fluid. On Dec. 17 the operation wound was partially re-opened, and about two pints of foul pus were evacuated. Following this, the supposed granulations on the surface increased rapidly in amount, and began to undergo a superficial necrosis. At the same time the abdominal swelling became larger, in spite of the drainage which had been established. A microscopic section from the granulations was made on Dec. 24, and cells resembling those of round- and spindle-celled sarcoma were seen. It was evident at this stage that the original diagnosis would have to be revised, and a further examination of the kidney, which had been sent to the hospital museum, was undertaken.

It was now noticed that the wall of one of the calices in the lower



FIG. 164.—Case 1. Infiltration of the walls of the kidney with a squamous-celled carcinoma. The surface of the epithelium of the calix is shown at the top of the photograph ( $\times 95$ ).

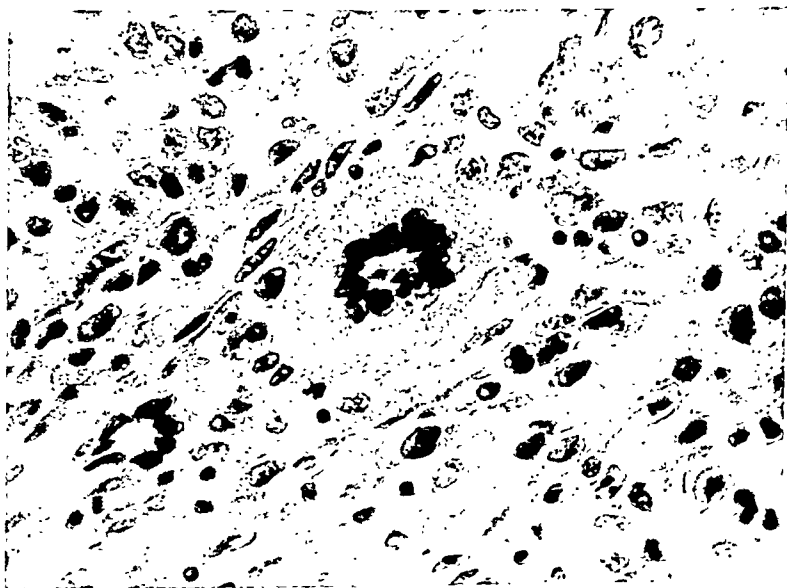


FIG. 165.—Case 1. Section of the growth immediately outside the kidney, showing metaplasia of the carcinoma cells, including giant-cell formation ( $\times 540$ ).

pole was thicker and of a whiter appearance than in the others (*Fig. 163*). Sections were made from this region, and it was found that no sarcoma cells were present, but that the wall of the calix was infiltrated with a typical squamous-celled carcinoma (*Fig. 164*). Immediately outside the kidney capsule the type of cell showed a considerable degree of alteration, even multinucleated giant cells being a feature of the growth in this situation (*Fig. 165*).

Meanwhile the patient's condition became rapidly worse, and he died on Jan. 10, 1921, eleven weeks after the removal of his kidney. During the last fourteen days of his life the growth in his flank increased in size with extraordinary rapidity, and at his death a black, fungating mass nine inches in diameter projected from his flank for two inches beyond the surface of the skin. The intra-abdominal tumour was as large as a child's head.

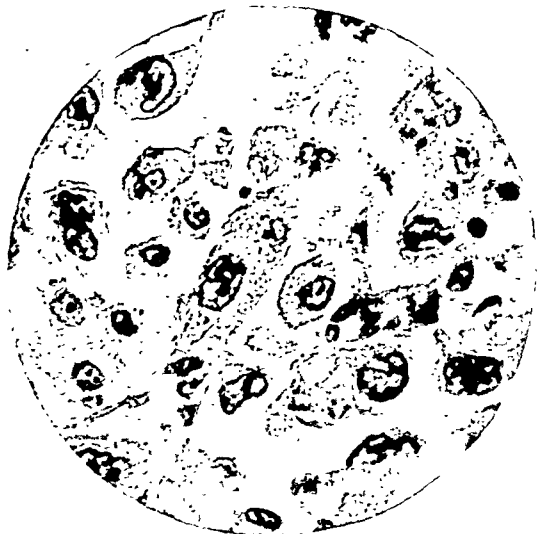


FIG. 166.—Case 1. Section of the recurrent growth in the flank ( $\times 540$ ).

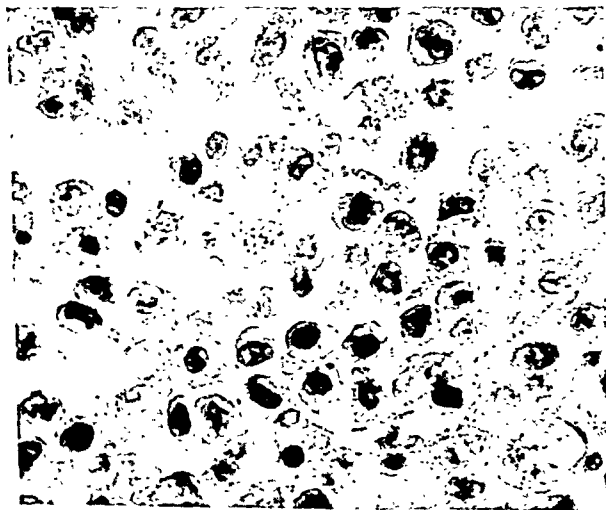


FIG. 167.—Case 1. Section of the metastatic growth in the heart ( $\times 540$ ).

At the autopsy very little of interest was found beyond the growth in the right flank already described. This was very soft and had become largely necrotic. The only metastasis that could be found was a lump the size of a marble in the muscle of the right ventricle of the heart. The patient's death was due primarily to cachexia and toxæmia.

Sections from the less necrotic parts of the growth showed an extreme degree of metaplasia of the cells, which, in the absence of other

evidence, it would have been difficult to assign to their true origin (*Fig. 166*).

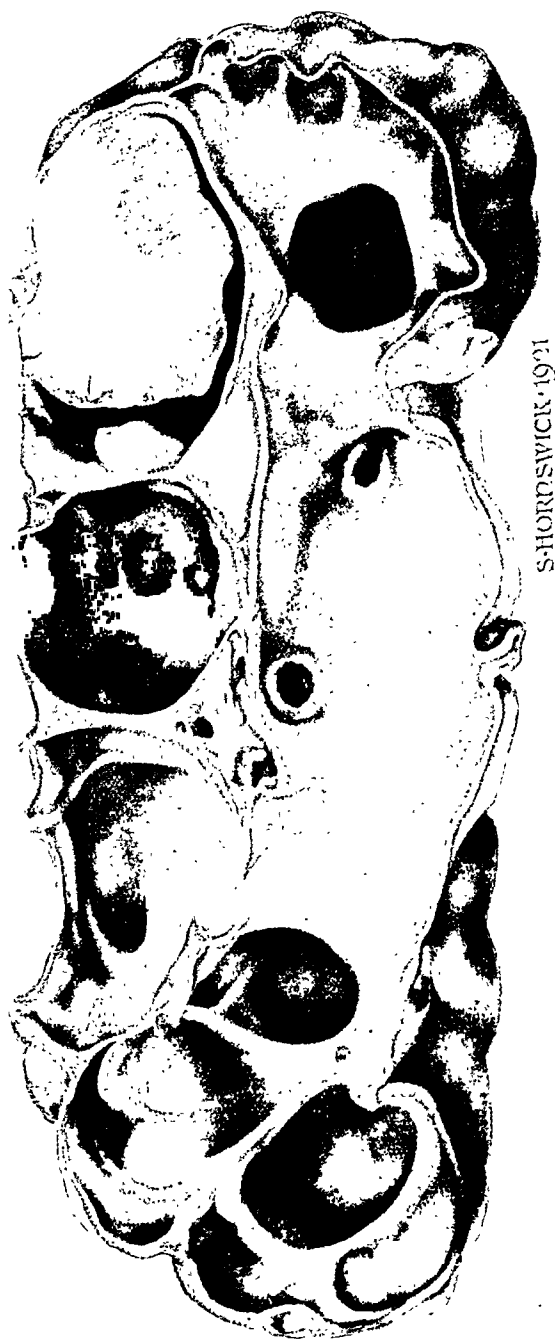


FIG. 168.—Case 2. Mesial section of the kidney, showing large malignant papilloma in a dilated calix near the lower pole.

These cells were of all shapes and sizes, and, but for the absence of any stroma, could not confidently have been designated carcinomatous. A section (Fig. 167) of the metastatic growth from the heart showed a more uniform type of cell, but the type was that of a more primitive, rounder cell than was found in the primary growth. In the luxuriant growth on the surface of the body the cells, as already described, had so far departed from their original form that they were believed to be sarcomatous. This observation suggests that some of the recorded cases of sarcoma of the kidney associated with calculus may have been in reality carcinomata, the primary lesion having been, as in the present instance, relatively inconspicuous.

CASE 2.—A night-watchman, age 54, had complained of no symptoms until May, 1921, when he noticed some blood in his urine. This was unaccompanied



FIG. 169.—Case 2. Section of the base of the malignant papilloma of the renal calix ( $\times 95$ ).

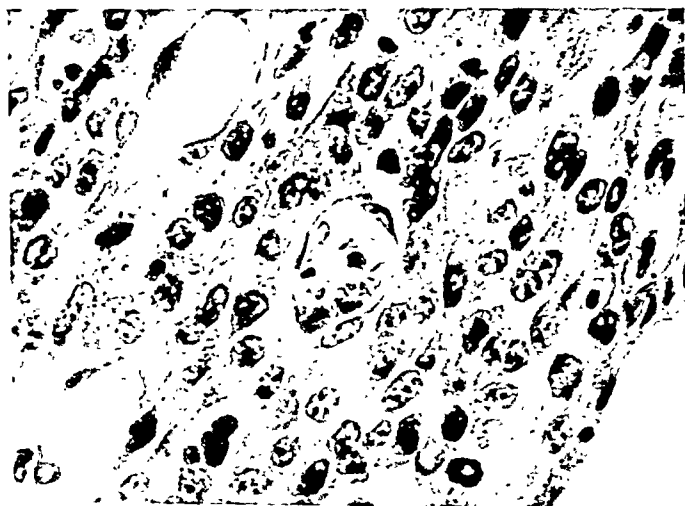


FIG. 170.—Case 2. Same as Fig. 169—higher power view ( $\times 480$ ).

by any pain, difficulty in micturition, or increased frequency. In June, 1921, the patient experienced attacks of severe pain in the lumbar region

on the right side. He came to hospital on account of pain, and was admitted on Aug. 15. He was then found to have a large, tense tumour in the left flank, which moved on respiration and was dull to percussion. His urine contained many pus-cells, a few red blood-cells, and many coliform bacilli. A cystoscopy showed that the efflux from the right kidney was normal, but that the efflux on the left side was very infrequent, and that no indigo-carmines was discharged from this side after intravenous injection. The blood-urea content was estimated to be 42 mgrm. per 100 c.c.

The left kidney was removed by Mr. T. P. Dunhill on Aug. 19, but not without difficulty, owing to its enormous size and to the presence of adhesions near the lower pole. The patient made an uninterrupted recovery, and was discharged from hospital, apparently well, on Sept. 10, 1921. His further history is not known, and no reply was received to inquiries made on several occasions during the two following years. The condition found on examination of the specimen makes it probable that he did not survive his operation for long.

The kidney which had been removed was very greatly distended, the cortex being reduced to a thin shell (*Fig. 168*). The pelvis was also greatly dilated, measuring 4 in. by 3 in., and its wall was hypertrophied. For some thirty minutes after removal of the kidney, any stimulus applied to the wall of the pelvis initiated a strong wave of contraction, which spread round the whole pelvis and culminated at the ureteric orifice. The ureteric orifice was small, but the ureter itself appeared to be normal. The gigantic pelvis, as seen in the figure, communicated through a number of holes with greatly dilated calices. These were filled with blood-clot, and in the biggest, situated in the lower pole, was a large papillomatous growth, surrounded by several smaller ones. The capsule of the kidney was missing over the area corresponding to these growths, the wall of the kidney having been adherent to neighbouring structures. Sections through the bases of these growths showed infiltration by cells of transitional epithelium, which had no tendency to keratinize (*Figs. 169, 170*).

In this case, therefore, there was a papillary squamous-celled carcinoma growing in the calix of a kidney affected by hydronephrosis of the congenital type. The ureter was normal, and no aberrant vessel was found obstructing the outflow of urine. Muscular co-ordination was seen to be normal in the renal pelvis, and it seems necessary, therefore, to postulate incomplete relaxation of the ureter itself in order to account for the condition. Whatever the cause of the hydronephrosis may have been, it had evidently been present for many years before the development of the carcinoma, which seemed only recently to have infiltrated through the wall of the kidney to the surface.

CASE 3.—A milk carrier, age 20, had complained of recurrent attacks of pain in his back in the left renal angle, accompanied by hæmaturia. The first attack was in March, 1923, and he had three or four similar attacks during the year. The patient was in severe pain when admitted to hospital on March 7, 1924. His urine contained much blood, and was found to be infected with a coliform bacillus. The left kidney could be felt to be somewhat enlarged, but was not tender. The mucous membrane round the left ureteric orifice was seen to be œdematous. Other investigations led to a tentative

diagnosis of hydronephrosis with hæmaturia being made, and the left kidney was removed by Mr. T. P. Dunhill on March 21.

Both the kidney and the pelvis were much enlarged, the wall of the pelvis being also hypertrophied (*Fig. 171*). The ureter had very much thickened walls, and the lumen was very narrow at the upper end. In the upper part of the pelvis were two chronic ulcers, the larger one being covered with a layer of fibrinous material. A considerable area of the rest of the pelvis was of an opaque whitish colour, apparently due to an early stage of leucoplakia. No abnormal renal artery was found, so that the kidney appeared to be in an earlier stage of the same condition as was found in *Case 2*. Hæmaturia is a not infrequent sign of hydronephrosis even in the absence of any ulceration, though it is not always mentioned in the published accounts of the disease. The patient in the present case was young, but had he not had severe pain as a symptom it seems probable that the lapse of another thirty years might have resulted in the production of a kidney resembling that of *Case 2*.

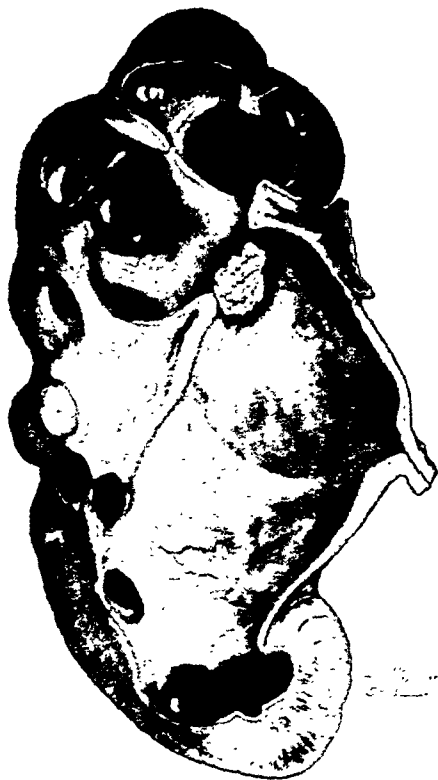


FIG. 171.—*Case 3*. Mesial section of kidney, showing chronic ulcers in upper part of dilated pelvis and early leucoplakia in the lower part.

All three patients were in the wards of the Surgical Professorial Unit, St. Bartholomew's Hospital, under Professor G. E. Gask, who has kindly allowed the cases to be published. The specimens here described are now all in the museum of the Hospital.

The microphotographs illustrating this article have been made by Miss M. Vaughan, Dunn Laboratory, St. Bartholomew's Hospital.

#### REFERENCES.

- <sup>1</sup> DARNALL, W. E., *Surg. Gynecol. and Obst.*, 1922, XXXV, 493.
- <sup>2</sup> HADFIELD, G., *Brit. Jour. Surg.*, 1924, xi, 583.

## SOME OBSERVATIONS ON THE PROGNOSIS IN ACUTE APPENDICITIS.

BY R. J. MCNEILL LOVE, LONDON.

HAVING recently analysed and published in the *BRITISH JOURNAL OF SURGERY* (April, 1923) the result of operations for acute appendicitis at the London Hospital for three years, 1920-22, it appeared that a fuller analysis might reveal some further points of interest; and in order to acquire further data I have included cases of acute appendicitis operated on during 1923—making a total of 2018 cases.\*

*Table A.*—PROGNOSIS REGARDING LOCAL CONDITIONS.

*Group I.*—Cases operated on within twenty-four hours of onset.

NO. OF CASES	RECOVERED	DIED	MORTALITY
221	219	2	Per cent 0·9

*Group II.*—Cases treated on delayed lines.

	NO. OF CASES	RECOVERED	DIED	MORTALITY
Inflammation subsided ..	232	227	5	Per cent 2·1
Unsuccessfully delayed ..	109	102	7	6·4
Total .. ..	341	329	12	3·5

*Group III.*—Cases in which immediate operation was performed (including *Group I*).

CONDITION PRESENT AT OPERATION	NO. OF CASES	RECOVERED	DIED	MORTALITY
Inflammation limited to the appendix ..	633	627	6	Per cent 0·9
Local peritonitis ..	467	438	29	6·2
Local abscess ..	347	331	16	4·6
General peritonitis ..	230	183	47	20·5
Total .. ..	1677	1579	98	5·8

In my previous article I attempted to elucidate replies to two questions—

\* I am indebted to the surgeons of the London Hospital for permission to include in the above series cases which were under their treatment or observation.

"When to operate" and "The best route for drainage". In this paper I propose to consider the prognosis of acute appendicitis with regard to local conditions present at operation, the duration of the attack, and the age of the patient, and I have summarized complications which occurred in this series of cases. The analysis of these groups gives additional support to those who advocate that the treatment of cases of acute appendicitis should receive individual consideration, in contradiction to the popular belief that all cases should be operated on as soon as diagnosed.

**Local Conditions at Operation** (*Table A*).—All surgeons are agreed that early cases of appendicitis should be operated on immediately while the infection is still limited to the appendix, that is, during the first twenty-four to thirty-six hours, or the period more accurately defined by the presence of a band of hyperæsthesia above Poupart's ligament, which denotes a distended and therefore intact appendix.

As seen in the above table, the lowest mortality (0.9 per cent) is naturally in cases operated on in this early stage. Then follows the quiescent group with a mortality of 2.1 per cent. This group consists of cases which had passed the period of safety and were then successfully tided over the acute period, and appendicectomy performed after inflammation had subsided. In addition to this, credit must also be given to the delayed treatment for converting many cases of local and general peritonitis into a localized abscess, which carries a lower mortality than either of these two antecedent conditions. Also, in comparing the mortality of *Groups II* and *III*, it must be noted that *Group III* includes *Group I*, i.e., 221 cases in which operation was performed within twenty-four hours. As the delayed group only consists of cases which have passed this early period, in order to obtain a true comparison of the mortality of immediate and delayed operations these early cases must also be excluded from *Group III*. We then find the mortality of cases in which immediate operation was performed is 6.6 per cent, compared with a mortality of 3.5 per cent in delayed cases.

Briefly outlined, the principles of delayed treatment, which were recommended by Sherren<sup>1</sup> as long ago as 1905, are as follows: If, after admission, it is decided that the appendix is perforated, local abscess is present, or general peritonitis has supervened, the patient is placed in Fowler's position, fomentations are applied to the abdomen to relieve pain, and only water is given by mouth. A four-hourly chart is kept, and over 70 per cent of cases subside, and permit of a subsequent clean appendicectomy. This is performed after the pulse and temperature have been normal for a week, or after the complete disappearance of local inflammatory swelling. This interval is usually within ten to fourteen days after admission, during which period the patient is given a fluid diet as soon as he desires such, and the bowels are only moved by an enema if indicated by abdominal discomfort. A word of caution is necessary with regard to the enema: rupture of an abscess has occurred from sudden distention of the lower bowel by a pint of soap and water; hence to reduce local disturbance to the minimum a small glycerin enema is given, which may be preceded by liquid paraffin by the mouth.

During the interval of delay, operation may be required for two reasons.

1. If after twenty-four hours of delayed treatment the pulse and



temperature show no indication to fall, or the patient complains of increasing pain or discomfort. This delay might be expected to influence the prognosis adversely; but figures show that such is not the case, the mortality being 6.6 per cent in cases operated upon immediately, and 6.4 per cent in the unsuccessfully delayed.

2. In certain cases a localized abscess forms which can be allowed to absorb in safety. Occasionally the abscess increases in size and causes marked toxæmic symptoms, in which case it is opened and drained in order to avoid rupture internally or on the surface. As it is very improbable that the appendix can be satisfactorily removed in the case of localized abscess, the drainage can be readily performed under nitrous oxide anæsthesia, and thus the risk and discomfort of the usual general anæsthetic avoided.

The local peritonitis group carries a relatively high mortality—6.2 per cent. Had treatment of this group been delayed, in all probability the majority of them would either have subsided or localized to form an abscess, and in either case the mortality would be substantially reduced.

Cases of general peritonitis subjected to surgical interference carry a notoriously high mortality; in 230 cases in this series the mortality was 20.5 per cent. Marsch,<sup>2</sup> in an analysis of 9000 cases, found that cases of general peritonitis carried a mortality of 17.5 per cent. Several factors combine to this end, probably the most important being the virulence of infection as compared with the patient's resistance, which is indicated pathologically by the inability of the tissues to form protective adhesions. Again, these cases are usually subjected to operation at the most inappropriate time, a factor which is discussed later.

*Table B.*—MORTALITY OF OPERATION ON THE DIFFERENT DAYS OF THE ATTACK.

NO. OF DAYS	INFLAMMATION LIMITED TO APPENDIX		LOCAL PERITONITIS		LOCAL ABSCESS		GENERAL PERITONITIS		TOTAL		MORTALITY
	Recor'd	Died	Recor'd	Died	Recor'd	Died	Recor'd	Died	Recor'd	Died	
1	191	1	52	1	20	0	16	1	279	3	Per cent 1.1
2	264	2	61	2	45	2	69	7	439	13	2.8
3	82	2	79	12	123	8	72	19	356	41	10.3
4	21	0	67	9	71	5	26	8	185	22	10.6
5	8	0	22	2	29	0	12	5	71	7	8.9
6	10	1	31	0	32	1	9	3	82	5	5.7
7	4	0	37	1	11	0	2	1	54	2	3.6
8	7	0	19	1	9	0	1	0	36	1	2.7
9	31	0	32	1	15	0	0	0	78	1	1.2
10 or more	133	1	88	4	57	1	3	1	281	7	2.4
Total	751	7	488	33	412	17	210	45	1861	102	5.2

**Duration of the Attack (Table B).**—This table emphasizes the accepted fact that operations from the third to the fifth day carry a high mortality. The mortality of operation on the first day is almost negligible (1.1 per cent); on the second day it is appreciable (2.8 per cent); from the third to the fifth day it is lamentable, being 10.2 per cent for this period. After the fifth day we find the mortality dwindles as the duration of history lengthens.

The most important factor which determines this high mortality of third to fifth day operations is the resistance of the patient, which at this period is at its lowest ebb. Natural immunity to the infection has been exhausted, and acquired immunity has not yet been established, i.e., the patient is in the 'negative phase'. Unnecessary operative interference at this period is obviously dangerous. Operative manipulations and the exposure of fresh surfaces and planes to infection accelerate the absorption of toxins at the period when the patient is unprotected and least able to deal with them.

Thyroid surgery furnishes an analogous condition; operative manipulation causes temporary hyperthyroidism, and hence a quiescent period is chosen for surgical interference. Again, during the war it was common experience that operations which had to be performed on the necessarily badly infected wounds soon after infliction caused exacerbation of toxæmia.

Delayed treatment allows the resistance of the patient to be re-established, and, even if an abscess forms which can only be opened without removal of the appendix, the mortality of the two-stage operation, i.e., opening the abscess and the subsequent clean appendicectomy, is substantially lower than operation during the dangerous period. Also, if localization is occurring at this period, however gentle operative interference may be, or however carefully packing is inserted, the early protective adhesions are easily separated and general peritonitis may result where only a local infection was originally present.

It is perhaps particularly in cases of general peritonitis that delay is valuable. However little manipulation is attempted in operation during the dangerous period, such manipulation accelerates lymphatic and venous absorption, so that toxins are suddenly absorbed when resistance is at its weakest. The rightly-condemned procedure of evisceration and extensive cleansing of the general peritoneal cavity produced acute toxæmia which was euphemized by the term 'shock', and operation in cases of general peritonitis causes toxic absorption in proportion to the amount of interference.

It is well known that cases of ascitic tuberculous peritonitis readily respond to laparotomy, as in these cases intra-abdominal tension is thereby diminished and the lymphatic and vascular channels are encouraged to dilate; hence antibodies flood the affected area. This argument is quite fallacious when applied to cases of acute peritonitis; operation promotes hyperæmia, but there are no antibodies in the blood; the actual result is that toxins are swept away before preparation has been made for their reception.

Cases of acute general peritonitis should be treated on similar lines to an acute cellulitis. In this condition it was formerly the custom to make free incisions into the brawny area, a line of treatment now superseded by conservative measures which allow infection to localize, and if abscesses occur these are subsequently opened. Similarly, general peritonitis should be given the opportunity to subside, and any local collection of pus—e.g., in the pelvis—is drained if toxæmia ensues.

If temporary measures can be successfully employed, the patient's resistance slowly increases; this is reflected in *Table B*, in which it is seen that the mortality decreases as the history lengthens.

**Age of Patient (Table C).**—It will be seen from *Table C* that the majority of cases of acute appendicitis occur between the ages of 10 and 30, the number in this series being 1290, or 67·5 per cent, occurring during these two decades. Suermondt,<sup>3</sup> in a series of 513 cases, found that 41·3 per cent occurred between the ages of 16 and 25. Flint<sup>4</sup> surmises that in young girls the onset of menstruation may predispose to inflammation of the appendix, and that this is particularly liable to occur at the onset of a period.

*Table C.*—COMPARISON OF MORTALITY AND AGE.

AGE	DELAYED CASES		INFLAMMATION LIMITED TO APPENDIX		LOCAL PERITONITIS		LOCALIZED ABSCESS		GENERAL PERITONITIS		TOTAL		MORTALITY
	Recov'd	Died	Recov'd	Died	Recov'd	Died	Recov'd	Died	Recov'd	Died	Recov'd	Died	
0-10	27	2	51	1	41	7	49	5	31	15	199	30	Per cent
11-20	132	3	281	2	172	10	107	5	67	22	759	42	13·1
21-30	93	2	189	1	131	6	79	2	39	4	531	15	5·2
31-40	41	3	69	1	57	1	38	1	28	1	233	8	2·8
41-50	32	2	28	0	21	2	41	2	9	3	131	8	3·3
Over 50	4	0	9	1	16	2	17	2	9	2	55	7	5·7
Total	329	12	627	6	438	29	331	16	183	47	1908	110	5·4

With regard to prognosis, the mortality is highest during the first decade. Several factors combine to this end. Minor gastro-intestinal disturbances are common during the early years, being chiefly due to injudicious or illicit diet, and hence an acute appendicitis presenting similar initial symptoms is treated as the minor ailment. Thus skilled advice is only sought after the failure of household remedies, which usually consist of laxatives or purgatives. These drugs merely cause intra-abdominal turmoil, which may effectively prevent the infection from localizing or subsiding, especially when administered after perforation or gangrene of the appendix.

Injudicious treatment by diet and drugs during the early stages of acute appendicitis probably explains the failure to subside in many cases in which delayed treatment is unsuccessful, and frequently the history of such cases supports this view. Children are commonly the unwilling recipients of this energetic treatment, the deleterious effect of which is reflected in the mortality list.

Again, the age and intelligence of young children naturally handicaps them in expressing their symptoms, and this may lead to symptoms being missed in the early stages, and the inadequate history may cause errors in diagnosis, so that inappropriate incisions may be made by the surgeon.

Finally, the resistance to infection is less pronounced at the two extremes of life, which is suggested by the fact that delayed treatment, though valuable, is not as uniformly successful in young children as in those of maturer years.

The second decade carries a higher mortality than the third or fourth, which is again probably due to the fact that erroneous diagnosis and treatment are common during the early stages of acute appendicitis in childhood.

The fifth decade shows a slight rise, and the mortality rapidly increases after 50, due to the lowering of resistance associated with the declining years.

Table D.—COMPLICATIONS DURING ATTACKS (1803 CASES).

Secondary abscess .. ..	52	Pulmonary complications—	
Subdiaphragmatic abscess .. ..	9	Empyema ..	2
Fæcal fistula .. ..	74	Pleural effusion ..	1
Phlebitis .. ..	7	Pleurisy ..	3
Intestinal obstruction .. ..	19	Pulmonary embolism	1
Parotitis .. ..	1		7

(Secondary abscesses were associated on one occasion with a fæcal fistula, and on two occasions with intestinal obstruction.)

Total: 169 in 166 patients; i.e., 9.4 per cent of cases presented one or more complications.

**Complications (Table D).**—I have previously analysed the complications occurring in acute appendicitis, and the addition of the cases for 1923 support the conclusion already drawn. Two points may be briefly mentioned:—

1. The incidental complications occurring in all the cases treated on delayed lines amounted to 6.7 per cent, compared with 11.9 per cent in cases subjected to immediate operation. One also would imagine that sequelæ—e.g., ventral hernia, adhesions, etc.—would show an even greater disproportion in these two groups of cases.

2. Complications following drainage through a gridiron incision still show a marked increase over complications following stab drainage. This drainage may be either suprapubic, or in the loin, or a combination of these two routes.

### SUMMARY.

1. When cutaneous hyperæsthesia has disappeared in a case of acute appendicitis, delayed treatment will usually allow the infection to subside.

2. A tentative period of delay does not adversely influence the prognosis, and, combining all cases treated on delayed lines, the mortality, as compared with cases operated on immediately, is nearly halved.

3. Delayed treatment is less uniformly successful at the two extremes of life: in children partly because purgatives are freely administered, and in both cases because resistance to infection is low.

4. The mortality of cases subjected to operation is notoriously high from the third to the fifth days, and especially at this period should delayed treatment be given a trial, so that the patient's resistance may be re-established.

5. Incidental complications in cases operated on immediately are approximately three times as common as in delayed cases.

6. The delayed treatment can only be applied satisfactorily under hospital conditions, when a rigid routine can be strictly enforced. Constant observations must be made regarding alteration of local signs and changes in the general condition of the patient.

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- <sup>4</sup> FLINT, *Practitioner*, 1920, May.

## ASEPTIC RESECTION OF THE INTESTINE.

By SETON PRINGLE, DUBLIN.

THE perfect method of performing intestinal anastomosis has yet to be evolved. There are still considerable differences in the details of the technique employed by different surgeons. Indeed, there is divergence of opinion even yet on such an essential matter as the relative advantages of end-to-end, lateral, and end-to-side anastomosis. We are all agreed, however, that the chief danger of the operation lies in the risk of infection, and in the endeavour to overcome this primary risk many efforts have been made to perfect an aseptic technique, and accounts of some of these have appeared in the medical journals from time to time.

Halsted<sup>1</sup> described a method of colectomy which he employed on dogs in forty-seven consecutive experiments without a single failure. He closed the ends of the colon which were to be united by a purse-string suture of silk, and approximated the closed ends by a single row of mattress sutures, completing the operation by puncturing the complete diaphragm thus formed by means of a special guarded knife which he introduced per rectum and which, by means of a long flexible metal handle, he was able to pass up the large intestine to the ileocaecal valve if necessary. He has shown that the internal shelf or partial diaphragm which was left by his procedure rapidly unfolded, and that, if unfolding was not complete, at any rate no serious obstruction occurred.

In another paper Highsmith<sup>2</sup> described a somewhat similar procedure; but he closed the ends of the bowel which he was about to unite by a strand of silkworm gut thrown round the intestine in the groove left by the application of a narrow crushing forceps. The strand of silkworm gut was held in a special 'loop clamp' which is very similar to a nasal polypus snare, the bowel being controlled by the loop of silkworm gut just as the base of a polypus is held by the wire loop of the snare. He then approximated the closed ends, and united them by a row of mattress sutures until only a small gap remained through which the shanks of the loop clamps passed. The loops of silkworm gut in the clamps were then cut and the clamps withdrawn, the lumen of the intestine being thus re-established. The operation was completed by a stitch or two closing the small aperture left by the withdrawal of the clamps.

The work of these two men was experimental, and there is no report of either method having been tried on the human subject; but, in a recent number of the BRITISH JOURNAL OF SURGERY, Fraser and Dott<sup>3</sup> reported a method almost identical with that of Highsmith. They carried out a number of experiments on dogs, and, satisfied with the results, successfully adopted the method in two cases of colectomy for cancer of the colon. In their experiments they confirmed Halsted's finding that the internal shelf left

by the operation rapidly unfolded, but in one patient they had subsequent trouble from persistence of this shelf—trouble which they ascribed to excessive infolding of the bowel.

I have recently employed a method similar, but with several differences in detail—differences which I consider important and tending to perfect the method.

### STEPS OF THE OPERATION.

1. The bowel is mobilized, the extent to be resected determined, and the main vessel at the apex of the V-shaped piece of mesentery to be excised is ligatured; any other vessels along the lines of the V running up to the points of section of the intestine are secured, and the mesentery is then divided.

2. A large crushing clamp with blades 1 in. wide is applied to the

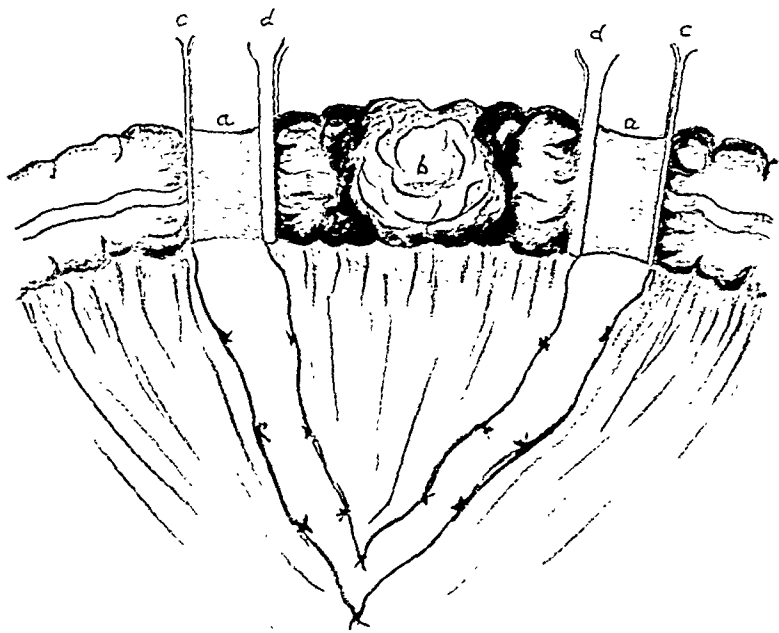


FIG. 172.—*a a*, Crushed segments of intestine above and below the growth *b*. *c c*, Light forceps grasping crushed tissue and controlling the two ends of bowel to be united. *d d*, Heavy clamps controlling the ends of the segment to be removed.

intestine at the point above the growth selected for division (Fig. 172). The crushed portion close up to the proximal end of the intestine is caught with fine but strong forceps (Fig. 172. *c*). The blades of this forceps are  $2\frac{1}{2}$  in. long by  $\frac{1}{2}$  in. wide, with longitudinal serrations. The forceps is applied across the intestine so that the tip rests just short of the mesenteric attachment—it is important that the tip should not project beyond the margin of the

crushed intestine. When this forceps has been placed, the crushed segment of the bowel close up to the edge of the portion to be removed is grasped in an ordinary heavy straight clamp (*Fig. 172, d*). The intestine is then divided through the crushed portion, the knife, as it were, shaving along the lighter forceps, and liquid carbolic acid is applied to the cut edge. The intestine at the site for division distal to the growth is similarly treated, the light forceps being applied to the distal edge of the crushed portion.

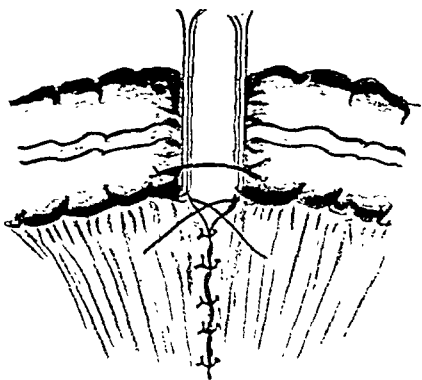


FIG. 173.—The placing of the first mattress suture closing the V gap in mesentery.

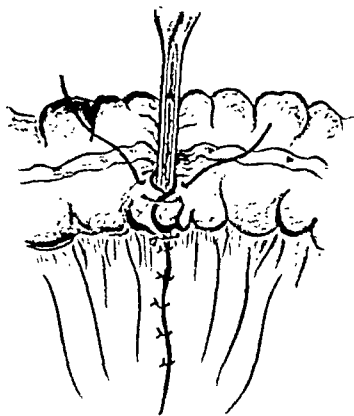


FIG. 174.—Forceps approximated, first mattress suture tightened, second suture in place.

3. The edges of the divided mesentery are then united up to within an inch of the attachment to the bowel. The two light forceps controlling the ends of the intestine are held in apposition by an assistant. A needle carrying 00 chromic gut is passed through the two leaves of the mesentery bounding the triangular space at the attachment to the intestine, and then picks up the bowel wall  $\frac{1}{4}$  in. lateral to the forceps and close to the mesenteric attachment. The needle is carried across, and the bowel in the other forceps is similarly picked up; the needle then emerges through the two leaves of the mesentery on the side opposite its original insertion (*Fig. 173*). This stitch when tightened closes the mesenteric gap, and buries the tip of the forceps in a gutter of infolded intestine (*Fig. 174*). A series of mattress sutures, each penetrating to the submucosa, are then passed, burying the forceps from either side, so that when completed the only place where

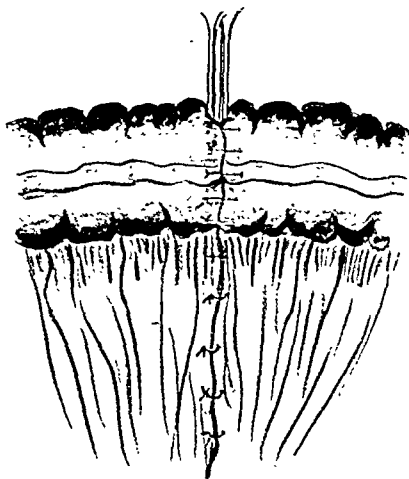


FIG. 175.—Row of mattress sutures completed.

the serous coats of the intestine are not in contact is at the point of emergence of the forceps (*Fig. 175*). Another layer of continuous or interrupted sutures is applied to approximate the intestine further, and, finally, the clamps are loosened and withdrawn and the small gap thus left sutured. When the suture line is completed, if the intestine is picked up between finger and thumb so that one lies above and the other below the line of anastomosis, a free opening will be found to exist between the two segments (*Fig. 176*).

The similarity between the above method and those already reported is obvious. In some details—such as the method of suture—they are practically identical; but there are two points of difference. First, the bowel is divided through a previously crushed portion, so that the mucous membrane is never exposed and the risk of infection is thus reduced to a minimum. Halsted and Highsmith cut through the mucous membrane so that a cuff of it is exposed distal to the encircling ligature, while Fraser and Dott divide the bowel outside the grasp of the crushing clamp. Halsted has shown conclusively that infection of the peritoneal coat round the anastomosis delays, or may even prevent, the unfolding of the internal shelf formed in this method of anastomosis; and so, apart from any risk of gross infection, it is essential



FIG. 176.—Diagrammatic representation of longitudinal section of anastomosis.

that every possible care should be taken to avoid even the slightest chance of contamination. In the second place, I think the use of the clamp as opposed to the use of encircling ligatures lessens the possibility of permanent internal shelf-formation, as the infolding mattress sutures can be placed much closer up to the clamp than to the encircling ligature. Another advantage of my method is that no special instrument such as

Halsted's knife, Highsmith's 'loop clamp', or Fraser's 'ligature guillotine' is needed.

The chief criticism that is likely to be directed against this method is the fact that mucous membrane is not sutured to mucous membrane. The experimental work carried out by those workers already referred to showed conclusively, I think, that suture of the mucous membrane was not necessary either for immediate union or final repair. Schoemaker,<sup>4</sup> however, employs a technique in which he makes a circular incision round the intestine through the serous and muscular coats and turns back a cuff of these layers, thus leaving a tube of intact mucosa on which he places two small clamps close together, and divides the intestine between them. Having removed the desired segment of the intestine, the two ends still closed by the clamps are approximated, and end-to-end union is made with an inner sero-musculo-mucous and an outer sero-muscular layer of stitches. The controlling clamp is removed as the last stitch of the inner layer is tied, and thus the anastomosis is completed without the lumen of the bowel having been opened during the operation. There seems to me a distinct possibility of infection from very slight errors in his technique. First, in making the circular incision and in turning back the sero-muscular cuff the mucous membrane might



conceivably be opened; and, secondly, in cases where the bowel above the obstruction is dilated and thin, it must be extremely difficult to take up the mucous membrane with the deeper stitch without penetrating the lumen, or even producing small tears. It would appear therefore that Schoemaker's method introduces certain complications and risks to gain an object which experimental and clinical work has shown to be unnecessary.

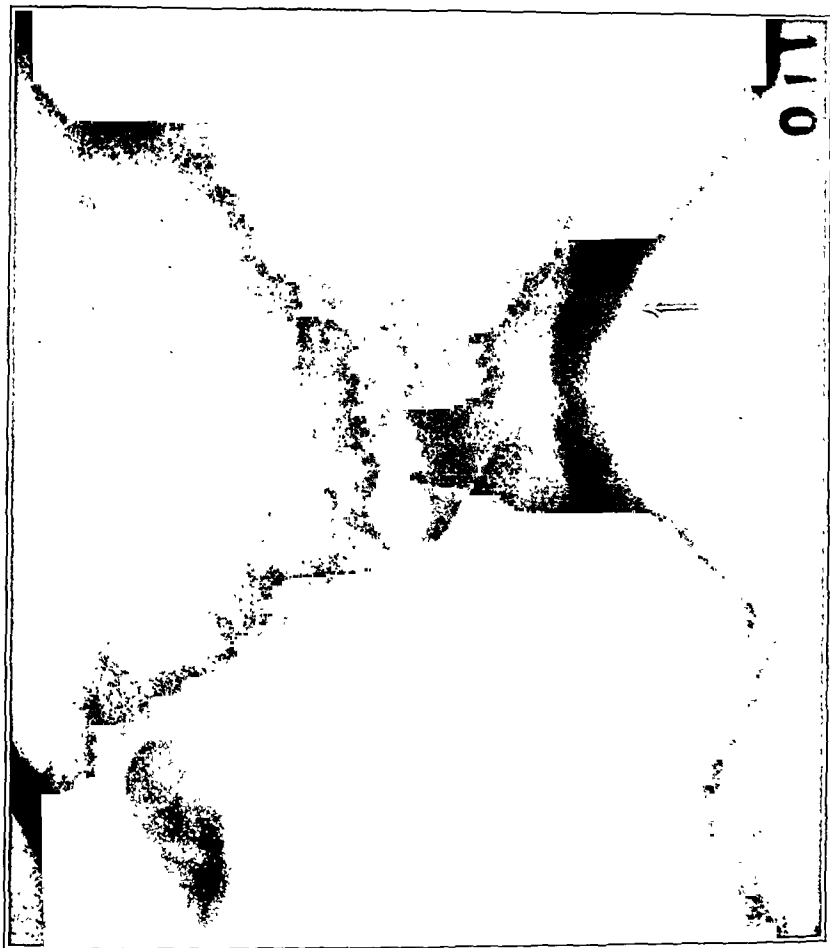


FIG. 177.—Result of barium enema four weeks after resection, demonstrating absence of obstruction. The site of anastomosis is indicated by the arrow.

I have carried out my method in three cases, of which short notes are appended. In each the time of operation was shorter, the hæmorrhage less, and the risk of infection enormously diminished, as compared with other methods. In each the immediate recovery was excellent; none of the patients had the slightest sign of local or general infection, and convalescence in all three was remarkably smooth.

# CASES.

*Case 1.*—A. W., male, age 62. Admitted with subacute intestinal obstruction. After five days' preliminary treatment with purgatives and enemata, the abdomen was opened and a cancer of the iliac colon resected, end-to-end anastomosis by the method above described being carried out. The operation was completed by performing a cæcostomy. Convalescence was quite uneventful, the cæcostomy gradually contracting, and the bowels moving per rectum three weeks after the operation. The X-ray (*Fig. 177*) demonstrates the absence of any obstruction, though the site of anastomosis is indicated.

*Case 2.*—M. L., male, age 52. Admitted complaining of diarrhœa for past year. The middle two-thirds of the transverse colon were obviously filled with a faecal mass : there was also a hard, nodular tumour to be felt in the right iliac fossa. With purgatives and enemata the colon was emptied, and five days after admission the abdomen was opened. It was then found that there was a cancer of the cæcum, with a second pedunculated tumour of the transverse colon. The small intestine was divided 6 in. above the ileocæcal valve, the colon was resected to within a few inches of the splenic flexure, and end-to-end anastomosis of the small intestine to the colon carried out. The bowels moved per rectum on the fourth day, and convalescence was quite uneventful. Microscopical examination showed that both tumours were carcinomatous.

*Case 3.*—J. J., female, age 52. Admitted with subacute intestinal obstruction. As enemata failed to relieve, cæcostomy was carried out. Twelve days later the abdomen was reopened and a cancer of the splenic flexure resected, end-to-end anastomosis being performed. In this case also convalescence was uninterrupted, apart from the fact that some pouting of the mucous membrane took place through the cæcal opening, and a plastic operation was required for its closure. Following the latter operation the action of the bowels was normal, liquid paraffin being the only aperient needed.

*Note.*—A fourth successful resection of the colon, with end-to-end anastomosis of the ileum to the transverse colon by this method, has since been performed.

I wish to express my indebtedness to Dr. E. C. Smith for the drawings which illustrate this paper.

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- <sup>2</sup> HIGSMITH, *Surg. Gynecol. and Obst.*, 1923, Feb., 271.
- <sup>3</sup> FRASER and DOTT, *Brit. Jour. Surg.*, 1924, Jan., 439.
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## POLYCYSTIC DISEASE OF THE KIDNEYS.

(*Congenital Cystic Kidney.*)

By ROY F. YOUNG, GLASGOW.

THIS disease is characterized by the presence of multiple cysts in the kidney substance. In the great majority of cases both kidneys are affected. That this condition can no longer be regarded as a pathological curiosity is proved by the numerous illustrative contributions on the subject in the medical press within the last fifteen years. The following five cases, seen within the last five years, provide additional evidence.

*Case 1.*—J. N., male, age 52. Admitted to hospital in May, 1919, complaining of pain in the right flank. For two years he had suffered from a dull, gnawing pain in the right lumbar region, and increasing unfitness for work, but no noticeable loss of weight. After admission a tumour of the right kidney was discovered, and the kidney was removed. This proved to be a cystic kidney. I did not see this patient till five days after operation, by which time uræmic symptoms had developed, with hiccup, drowsiness, and scanty output of urine. The left kidney was enlarged, elastic, and movable. The patient died thirteen days after operation.

A post-mortem examination showed the left kidney to be enlarged and cystic, with little normal tissue between the cysts. There were no changes in the liver, nor any other evidences of developmental defects. Nor was there any history of similar disease in the family.

*Case 2.*—F. W., male, age 36. Admitted to the Western Infirmary, Glasgow, in January, 1922. Seven years previously, he states, he received a blow on the left flank, which was followed by hæmaturia of six days' duration. Two years later he had another attack of hæmaturia. On neither occasion was there any pain. His next attack was four weeks before admission, when the amount of blood passed was large, and was accompanied by a sharp, stabbing pain in the left side. His previous health was good; the family history negative. A large elastic tumour could be felt in the left lumbar region, but the right kidney could not be palpated. The liver was not enlarged, but the superficial venules over the lower hepatic area were dilated. Urine: 1020, acid, large amount of blood; the microscopic deposit showed red blood-cells only. Blood urea: 41.4 mgrm. On cystoscopic examination the bladder was found to be healthy, the right ureter normal, but blood was coming from the left ureter. Two days later, as the hæmorrhage was increasing, the kidney was exposed from the lumbar route, and a large polycystic kidney, free from adhesions, was found. On account of the hæmorrhage the kidney was removed. The kidney measured  $6\frac{1}{2}$  by  $3\frac{1}{2}$  in. To the naked eye the normal kidney tissue was replaced entirely by cysts; the pelvis was distended with blood.

After operation the amount of urine passed in twenty-four hours, which had been within normal limits, fell, varying from 10 to 30 oz. He also developed a persistent hiccup which lasted for sixteen days. By the eighteenth day the urine reached normal limits, and when he left hospital, five weeks after operation, it averaged between 50 and 60 oz. Two days prior to leaving hospital the urine was acid, 1018; no albumin or blood; a few hyaline casts were seen by microscope. The blood urea was 54.9 mgrm.

He reported in March, 1922, about ten weeks after operation. He had put on

one stone in weight. At the end of April he was feeling well, but felt an occasional dull aching in the right loin. The lower pole of the right kidney could now be palpated, but was not tender. Urine: 1025, acid, no blood or albumin; passing about 40 oz. in the twenty-four hours. Blood urea: 46.3 mgrm. Reported in March, 1923. Had kept well, was well nourished and was not losing weight. Had been at work for ten months. Lower pole of right kidney palpable, but felt firm, and of normal contour. Blood urea, 38.7 mgrm.; urea concentration, 2.3 per cent; urea concentration factor, 45.

In February, 1924—two years after operation—his health remains good, he is able for full work, is not losing weight, and does not suffer from pain or discomfort. The kidney has not increased in size, and the urine is healthy, about 50 oz. being passed in the twenty-four hours.

In this case it appears reasonable to suppose that the cystic disease was unilateral.

*Case 3.*—G. E., male, age 36. Admitted to the Western Infirmary, Glasgow, in November, 1922, with a history of occasional attacks of hæmaturia of five years' duration. In June, 1917, while on active service in France, he had his first attack of hæmaturia, for which he was treated in hospital as a case of nephritis. The next attack was in 1919. There were subsequent occasional attacks of hæmaturia, the bleeding lasting for two or three days. In September, 1922, during another attack, the left kidney was found to be enlarged. He has never suffered pain on any occasion. Family history is negative.

On admission, a firm, elastic tumour was present in the left side, occupying the left lumbar and hypochondrial regions, and extending forward into the umbilical region. The tumour moved with respiration, and could be pushed forward from the back, but was not tender. The right kidney was also enlarged, but to a much less degree. Urine: 1016, neutral, small amount of albumin; on microscopic examination of the deposit a few pus-cells were found, but no red blood-cells nor organisms. The amount of urine varied from 60 to 95 oz. in the twenty-four hours. Blood urea, 63 mgrm.; urea concentration test, 1.2 per cent; urea concentration factor, 16. On cystoscope examination the bladder and ureter openings appeared quite healthy. A diagnosis of bilateral polycystic disease of the kidneys was made.

He was readmitted in September, 1923, for examination. In the interval he had been at full work as a platelayer, and had kept well. Both kidneys had increased in size. The blood-pressure was 170, but the heart was not increased in size. Urine:

1010, acid, with a trace of albumin; the deposit showed some pus-cells and triple phosphate crystals, but no blood. The amount of urine in twenty-four hours was low for two days, but this was succeeded by a polyuria of from 80 to 90 oz. Blood urea, 72 mgrm.; urea concentration test, 1.0 per cent; urea concentration factor, 12.5. An X-ray examination showed the diaphragm on the left side to be at its normal level. With a barium enema the descending colon was seen to be pushed well over to the middle line, while the ascending colon occupied its usual position.

Readmitted in January, 1924. He had been at his work until a fortnight

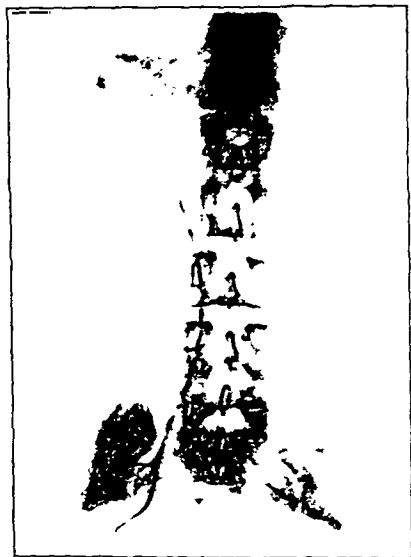


FIG. 178.—Case 3. Pyelogram of left pelvis.

previously, when he had to discontinue owing to a gnawing, jagging pain in the left side, which lasted two days but was not accompanied by hæmaturia. A week later he suffered from a complete obstruction of the colon for three days. He has been losing weight. There was an obvious further enlargement of the left kidney, which now reached almost to the umbilicus, and was visible on inspection. The right had remained much as before. Blood-pressure, 160. Urine: 1007, acid; no albumin; triple phosphates, only, found in the deposit. Blood urea, 95.6 mgrm.; urea concentration test, 0.9 per cent; urea concentration factor, 8.4.

Mr. Walter Galbraith kindly undertook the pyelography of the kidneys. That of the left kidney, which is here reproduced (*Fig. 178*), does not show any definite characteristic, while it was found impossible to get any clear shadow on the right side, possibly on account of pressure on the pelvis.

As the left kidney, on account of its bulk, had threatened on occasions to cause intestinal obstruction by pressure on the descending colon, it was decided to attempt to lessen the bulk of the kidney by operative means. Under local anaesthesia the organ was exposed through the abdominal wall where the tumour was most prominent. This portion of the kidney, at its lower pole, was incised, and about 5 oz. of fluid were evacuated. This fluid had all the appearances of altered blood, and did not contain urine. The edges of the incision in the kidney were sutured to peritoneum, and the cavity packed through this. He made an uninterrupted recovery, but the cavity still requires packing. His general health is good.

On examination of the specific gravity of the separated urines, that from the left—and more extensively affected—kidney was between 1000 and 1005, while that from the right was between 1005 and 1010.

*Case 4.*—Mrs. B., age 52. Admitted to the Royal Alexandra Infirmary, Paisley, in March, 1923, with a swelling in the left side of the abdomen, which had first been observed two years previously, but had caused neither pain nor discomfort. It had gradually increased in size, and on admission she complained of an aching, dragging pain in the side, which was worse when she was up. There was



*Fig. 179.*—Photograph of kidney removed in *Case 4*. Each square of the background measures one inch.

some frequency of micturition, small quantities of urine being passed at a time. There was some discomfort after food, with occasional vomiting, increasing anorexia, and loss of weight. The left kidney was enlarged, elastic, and movable, but the right kidney was not enlarged, nor was there any enlargement of the liver. Urine: 1010, acid, with a trace of albumin. In the deposit were present pus-cells, a few red blood-cells, and scanty hyaline and granular casts. Urea concentration test, 2 per cent. X-ray examination was negative, but with a barium enema the descending colon was seen to be pushed inwards towards the middle line. On cystoscopic examination the bladder and ureter openings were seen to be healthy.

At operation the kidney was exposed through the abdominal route, and was found to be cystic. The right kidney was examined by palpation, and appeared to be normal in size, shape, and consistency. The left kidney was removed.

Report on kidney by Dr. Hannay (*Fig. 179*): Weighs 13 oz.; irregular shape, measuring  $6\frac{1}{2}$  by 4 in. at upper pole, by 1 in. at lower pole. It is solid in the central part, and cystic at each end. The ureter is not dilated. The renal artery is smaller than normal. On section there is a spherical, encapsuled cyst, 3 in. in diameter, at the upper end, and a sausage-shaped cyst,  $2\frac{1}{2}$  by 1 in. at the lower pole, with a small amount of kidney substance in front of each, and a larger quantity between them. There is no dilatation of the pelvis. There are about a dozen smaller cysts in the remaining kidney tissue. There is recent extravasation of blood in the adipose tissue surrounding the pelvis. The fluid in the two large cysts measures 6 oz., and resembles urine.

Report on microscopical appearances (*Fig. 180*): There are a number of small cysts in the cortex and medulla, some of them giving rise to a certain amount of compression of the adjacent renal tissue; these cysts are lined by a single layer of flattened cells. The cortical epithelium shows some degenerative change, chiefly fatty. In places there is a slight increase of interstitial tissue. The blood-vessels are not abnormal.

This patient made an uninterrupted recovery, and left the hospital a month after operation. The urinary output, which had been low, remained so after operation, averaging 20 oz. in the twenty-four hours.

In November, 1923, she was readmitted, complaining of pain in the right side of an aching character, also of frequency of micturition, and a scalding pain during the act. For the past three months she had suffered from headache and defective eyesight, and had noticed a puffiness under the eyes in the morning, and some swelling of the legs at night. The right kidney was enlarged, movable, but not tender. Urine: 1014, acid, with distinct albumin; deposit showed pus-cells and organisms which, on culture, proved to be *B. coli*. She left hospital much improved under treatment with bicarbonate of soda.

In February, 1924, her condition was satisfactory. She was fit to carry on her work, and did not suffer from any pain. Her weight was the same as on previous admission. The kidney apparently had not increased in size, but felt somewhat irregular. Urine: 1004, acid, with a trace of albumin; no pus, casts, or organisms were found. Oedema of the eyes was still present in the morning.

In this case it is impossible to say if the right kidney has undergone cystic changes. The enlargement may be due to hypertrophy, but the irregularity is suspicious.

*Case 5.*—F. M., male, age 42. Admitted to the Western Infirmary, Glasgow, in September, 1923, complaining of attacks of hæmaturia of five months' duration.



FIG. 180.—Section ( $\times 40$ ) through pyramidal portion of kidney in *Case 4*, showing one small cyst and portion of another.

In 1917, while in the army, he was treated for nephritis. Apart from this his previous health had been good. The family history was negative. During the last two years he has gradually been losing weight. Five months ago he had an attack of hæmaturia, and since then he has had occasional similar attacks. At no time was there any pain.

Both kidneys were found to be distinctly enlarged, elastic to the touch, and movable, the right kidney being larger than the left. The liver was not enlarged, and other developmental defects were not present. The heart was not enlarged; blood-pressure, 160. Urine: 1016, acid, with trace of albumin; the deposit contained a few pus-cells. The output of urine in the twenty-four hours varied between 40 and 70 oz. Blood urea, 26.4 mgm.; urea concentration test, 1.7 per cent; urea concentration factor, 49. On cystoscopic examination the bladder was seen to be healthy, and urine was coming from both kidneys.

The diagnosis was made of bilateral polycystic disease. I have not been able to get in touch with this patient since.

### PATHOGENESIS.

The cause of the formation of these cysts has not yet been established, but several explanatory hypotheses have been advanced. The earliest is that of Virchow, who believed that the condition was due to an intra-uterine obstruction of the kidney tubules by uric acid and lime infarcts. Subsequently he considered that it was due to an intra-uterine papillitis, produced by the uric acid and lime infarcts causing atresia and obliteration of the collecting tubules.<sup>1</sup> His opinion was based on the presence of a round-celled infiltration with accompanying interstitial nephritis and atresia of the papillæ. This explanation is no longer accepted. It has been pointed out that these inflammatory changes are a result, not the cause, of the cyst formation, "a view which is supported by the greater density of the sclerosis round the larger than round the smaller cysts"<sup>2</sup>; also, as Tow points out,<sup>1</sup> many cases of cystic kidney have been reported in which papillitis could not be demonstrated. Virchow's explanation also fails to explain the developmental defects which are met with, apart from the kidneys, in many of these cases.

The most attractive hypothesis, and the one which receives most support, is that of Kuster, who attributed the cyst formation to an irregular congenital development of the kidneys. The ureter arises as a tubular diverticulum from the Wolffian duct, and from the ureter are developed the pelvis and collecting tubules of the kidney. The uriniferous secretory tubules, on the other hand, are formed in mesoderm, known as the metanephric cell mass. As the collecting tubules grow out into the developing kidney, they acquire connections with the uriniferous tubules.<sup>3</sup> Failure to establish a junction between these tubules would result in the formation of cysts within the uriniferous tubules. In the records of the post-mortem examinations of the Royal Hospital for Sick Children, Glasgow, there is an interesting case of congenital absence of one kidney, which would appear to corroborate this view of these cysts:—

No. 387. Male infant. Imperforate anus and hypospadias. On the left side the kidney is in its normal position, but larger than normal. On the right side the kidney is absent, also the ureter and renal vessels. In place of the kidney there is a small cystic mass.

A possible explanation of this may be that the metanephric cell mass was formed, but, owing to the failure of the Wolffian duct process to develop, cystic dilatation occurred in the embryonal structure.

The presence of liver cysts and other congenital maldevelopments associated with many of these cases serves to strengthen this view; also the history of hereditary polycystic disease in some families. If this view of congenital development be correct, it is difficult to understand why the disease should be commoner in the middle-aged than in the young, unless one concludes that the cysts remain latent in youth, and, with the advent of age, commence a gradual increase in size, at a time when more stress is thrown on the kidneys, whose power to respond is diminishing. McKinlay, agreeing with their congenital origin, believes that such cysts may remain quiescent, but that, when present in sufficient quantity to stimulate hyperplastic compensatory change in the renal parenchyma, the lesion will be a progressive one.<sup>4</sup>

A third hypothesis, which has received considerable support, suggests a neoplastic origin of the cysts, of the nature of a multilocular cystadenoma. Brigidi and Severi, in 1870, formed this opinion because of an increase in the number of layers of epithelium lining many of the cysts, the presence of epithelial sprouts with surrounding connective tissue from the walls of the tubules, and a pseudo-papilliferous formation on the inner walls of many of the cysts.<sup>1</sup> Against this it has been pointed out that similar epithelial changes were found by Busse to be present in all embryonal kidneys. Also, the changes such as described above are not constant, the epithelial elements frequently being diminished and replaced by connective tissue. McKinlay considers that proliferation of the epithelial lining of the tubules, even attempts to form new, possibly atypical, tubules, may be evidence of compensatory effort by the healthy parenchyma of an organ whose efficiency has been handicapped by malformation.<sup>4</sup>

### POSSIBLE ETIOLOGICAL FACTORS.

Certain factors, common to a number of cases cited in the literature, help to throw some light on this condition.

**Heredity.**—It would appear to be unusual to find a family history of polycystic disease, but there are undoubted authentic cases on record. Eisendrath<sup>5</sup> found one family in which five members had this disease. Tow cites Dungar for several examples: Virchow's case of four children of the same mother in all of whom polycystic kidneys were found; five children of another mother; a father, son, and nephew; and a father, son, and sister, with symptoms in other children of the same family.<sup>1</sup>

**Age.**—Clinically the disease is met with at two periods of life—in infancy and middle life. The occurrence in infancy is rare, and it is seldom found between infancy and twenty-one years of age. In the post-mortem records of the Royal Hospital for Sick Children, Glasgow, since 1915, out of a total of 1411 cases, there is only one case of polycystic disease of the kidneys, unless the one mentioned above is included (No. 387).

No. 748. Male, age 41 weeks. The left kidney shows congenital cystic malformation. It is increased in size to that of an adult kidney, and is converted into a mass of thin-walled cysts with clear or dark-coloured contents, and no trace of intact kidney substance is found. The right kidney, liver, and spleen are healthy.



Ballantyne mentions a case in which delivery of the child at birth was obstructed by a renal tumour of this nature.<sup>6</sup>

**Sex.**—It is generally agreed that this disease is commoner in females than males. In the cases reported here, four were males and one a female.

**Other Congenital Deformities.**—There are numerous examples where polycystic disease of kidneys is associated with other congenital deformities. Cysts in the liver are not uncommon; Moschowitz<sup>7</sup> estimates their association as 19 per cent, and Eisendrath<sup>5</sup> as 18 per cent of cases. Other deformities which have been noticed are hare-lip, cleft palate, spina bifida, meningocele, hypospadias, and cardiac defects. Ballantyne quotes a case of associated hydrocephalus,<sup>6</sup> and Thomson-Walker one of horseshoe kidney. In my cases no associated deformities were discovered. In the post-mortem reports of the Hospital for Sick Children, mentioned above, though there are several cases of horseshoe kidney, in none of them was there cystic disease.

**Bilateral Disease.**—It is the exception to find the disease confined to one kidney. Kidd,<sup>8</sup> in collecting 149 cases from the literature, found that 9 were unilateral—6 on the left side and 3 on the right.

### PATHOLOGY.

The general naked-eye appearance of the kidney, in the majority of cases, is now well recognized. The kidney retains more or less its normal shape, but is enlarged, in some cases enormously so. The normal kidney tissue appears to be replaced entirely by numerous cysts of variable size, giving an appearance of what has been described as 'a bunch of grapes'. In other cases, such as *Case 4*, a considerable area of normal tissue is retained, which, however, shows numerous cysts under the microscope. To the naked eye this specimen (*Fig. 179*) approaches more closely the condition described as 'large, solitary cyst' of the kidney. It is very doubtful, however, whether the solitary cyst of the kidney should be differentiated from the polycystic kidney; in the majority of cases the presence of other cysts in the kidney will be found, and the origin of the cysts is probably the same in both conditions.

The fluid contents of the cysts are not distinctive. The fluid is a clear straw colour, unless there has been hæmorrhage into the cyst, when it becomes blood-stained or dark brown. Albumin, urea, and various salts are present.

The walls of the cysts are lined either by columnar or flat epithelium. In some cases this epithelium shows proliferation, at times having the appearance of intracystic papillary growths; in other cases, such as shown in *Fig. 180*, this proliferation of epithelium is absent. In the early stages, as seen in this same section, the neighbouring renal tubules are healthy, and there is little increase of interstitial tissue. With the increase of the cysts there is corresponding increase in the interstitial fibrous tissue, with pressure on, and gradual disappearance of, the renal tubules.

### SIGNS AND SYMPTOMS.

By some authors three stages of the disease are distinguished: the latent; the second stage, when the tumour is present; and the uræmic. The latent period is variously given as from three to ten years. If the congenital

theory of the causation be accepted, the length of the latent period must necessarily be that of the age of the patient at which the first sign of disease was established. The first sign by which disease is detected is said to be the presence of a tumour. Of the five cases here reported, however, in three the first evidence of disease was hæmaturia, all three of whom were males. In the detailed reports of cases which I have come across, this fact seems to be borne out, that in men the first sign is hæmaturia, in women tumour. The possible explanation may be that, in women, a transient hæmaturia may be more readily missed, or may be attributed to other causes.

**Premonitory Symptoms.**—A careful investigation into the history of each case will generally furnish some evidence of renal insufficiency prior to the onset of hæmaturia or the discovery of a tumour, such as headache, nausea and loss of appetite, with increasing unfitness for work. Some patients have recognized a progressive loss of weight.

**Tumour.**—Only by the discovery of a renal tumour is there any likelihood of a diagnosis being established. A bilateral enlargement of the kidneys makes the diagnosis practically certain. In the vast majority of cases the disease is bilateral, but one kidney is always in a more advanced stage than the other, in which it may not be easy to detect enlargement. In a few cases the disease is unilateral. The tumour feels elastic, but not fluctuant, and in some cases the irregular cystic protrusions on the surface may be detected. The kidney is not fixed.

**Pain.**—This is not a constant feature, only about one-half of the cases complaining of pain. It is felt in the lumbar region, and is commonly of a dull, aching character, seldom sharp or stabbing.

**Hæmaturia.**—According to some writers, hæmaturia is comparatively infrequent. Thomson-Walker, quoting Luzzato, puts it at 16 per cent, while Pousson found it in one-third of the cases.<sup>9</sup> It is probably much more frequent than this. In four of my five cases it was present. The hæmaturia is intermittent, painless, and not severe. There may be long intervals between attacks—as long as two years elapsing in one of my cases. Renal colic, due to clots, is conspicuously absent. In a few cases the hæmorrhage may be very severe, as in *Case 2* reported here. In one case, reported by Rolando,<sup>9</sup> the hæmorrhage, which lasted two weeks, was so severe that the bladder was distended with clot; and Eisendrath<sup>5</sup> states that the hæmaturia may be so severe as to cause death.

**Other Urinary Changes.**—The character of the urine is that of chronic interstitial nephritis, with a low specific gravity and an acid reaction. Microscopic examination of the sediment may show a few hyaline or granular casts; red blood-corpuscles and pus-cells are not infrequently present. In the majority of cases, polyuria is present until the late stages of the disease, but this is not always so. There is little difference in the urine from the two kidneys, but Fullerton<sup>10</sup> has recently drawn attention to an increased diuresis with lower specific gravity in certain cases of renal disease; in two cases of bilateral cystic disease he found that in one the disease was more advanced on one side, and that the specific gravity of the urine from that side was lower. This is also true of *Case 3*.

**Renal Efficiency Tests.**—There is not sufficient evidence as yet upon

which to form a definite opinion on this much-debated question. Of my cases, only one, *Case 3*, has had the blood urea, the urea concentration test, and the urea concentration factor adequately worked out. Other renal efficiency tests have been discarded as unreliable. In this case the failing renal efficiency is corroborated by the tests. *Case 2*, according to the tests, developed an improved renal efficiency after nephrectomy.

**X-ray Signs.**—The ordinary X-ray plates of the renal regions have not, in my experience, proved of any assistance in the diagnosis of this condition. The method of showing up the kidney by the introduction of oxygen into the surrounding tissues would doubtless be of assistance, but it is a method one would hesitate to employ in this condition. A barium enema will show if the colon is displaced towards the middle line, but where this is present the kidney can be palpated readily.

Rolando<sup>9</sup> claims that, in cases where the right kidney is enlarged but it is difficult to define the condition of the left kidney, X rays will show the presence of an increase in size, "The left kidney, when increasing in size, in place of growing downwards towards the iliac region, as occurs with the right kidney owing to the resistance of the liver, enlarges upwards and displaces the diaphragm upwards, so that the lowest border of the left lung, instead of corresponding with the level of the tenth rib, may lie at the level of the ninth, eighth, or even seventh rib". This was a well-marked sign in two of his cases, in one of which it was corroborated at the post-mortem examination. Since reading his article I have investigated this in two cases, but in neither was the level of the diaphragm raised, though in *Case 3* the left kidney was greatly enlarged.

**Pyelography.**—Braasch<sup>11</sup> states that the pyelograph will identify the cystic nature of the tumour in over half the cases, "The pelvic outline of bilateral cystic kidney is characterized by flattening of the calices, giving a general oval contour to the pelvis, in contradistinction to the retracted calices of the malignant tumour. Occasionally, however, a retraction of the calices may also be found with the bilateral cystic kidney, but it is then broad and open and not slit-like or narrow". Eisendrath has not found pyelography of much assistance. In the only case of those reported here in which pyelography was undertaken, nothing distinctive was found.

**Cystoscopic Examination.**—This is only of value by reason of negative findings. The bladder and orifices of the ureters are healthy in appearance. In the event of hæmorrhage, of course, the affected side will be discovered.

**Compression by Tumour on Surrounding Structures.**—This has only been noticed in one case here (*Case 3*), where pressure caused obstruction of the descending colon. Rolando<sup>9</sup> quotes several authors who cite cases where the renal tumour caused obstruction of the ascending or descending colon; also a case of Glaser's where pressure on the common bile-duct resulted in death from suppurative cholangitis.

**Cardiovascular Changes.**—These are dependent on the associated chronic interstitial nephritis, but may be present in infancy, as in Tow's case<sup>1</sup> of a boy six weeks of age with great hypertrophy of the left ventricle. In Rolando's six cases a transient hemiplegia occurred in three; and in McKinlay's case<sup>4</sup> the patient, age 30, was admitted with a hemiplegia,

advanced arteriosclerosis of the aorta and vessels being found post mortem. It is common to find the blood-pressure higher than normal.

**Presence of Other Congenital Defects.**—These were not present in any of my cases, but they have been observed by many writers and may help in arriving at a diagnosis.

**Uræmic Symptoms.**—These occur in the terminal stage of the disease, and are common to all advanced renal diseases.

### TREATMENT.

It is now universally agreed that operative interference, nephrectomy in particular, should be avoided in this condition. *Case 1* offers sufficient proof. In the few cases where the disease is unilateral, nephrectomy would be the correct treatment, but absence of enlargement of the other kidney—even when examined by intra-abdominal palpation, as in *Case 4*—is no proof that a latent cystic condition is not present. In *Case 2* I had to resort to nephrectomy because the patient's life was endangered by hæmorrhage. From the subsequent history of this case it would appear that the disease, very fortunately, was unilateral.

Apart from nephrectomy, less radical operative proceedings have been carried out. Fixation requires but passing mention. Rovsing has found puncture of the cysts to be of value in relieving pain. Thomson-Walker writes that nephrotomy with evacuation of the large cysts has been performed for pain, and may be tried in anuria. Marion<sup>12</sup> has found a modified form of decapsulation successful for the relief of pain in three of his cases. The capsule is adherent to the walls of the cysts, but decapsulation may be carried out by snipping off the capsule with scissors, thus opening up the superficial cysts, any outgrowths from the walls of which are also removed. Balfour<sup>13</sup> carried out similar treatment in two cases with the idea of reducing the bulk of the kidney. In both cases drainage was provided for but proved unnecessary. While such treatment cannot be regarded as curative, it suggests a reasonable procedure for the relief of renal tension, as evidenced by constant aching in the lumbar region, and anuria; also in cases where the actual bulk of the kidney may be causing obstructive pressure on neighbouring organs. As a general rule, however, operative treatment should be avoided, and the patient should be treated on the same lines as in chronic interstitial nephritis.

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- <sup>10</sup> FULLERTON, *Brit. Med. Jour.*, 1924, i, 188.
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## WHITE MYELOMA OF THE RADIUS.

By T. H. BURLEND and D. J. HARRIES, CARDIFF.

THIS case is interesting clinically as it shows that in children a graft of dead beef-bone gives much the same result as a living autogenous graft.

The patient, a girl, age 9, fell on her right arm in November, 1921, and was treated for a Colles's fracture; but as the swelling above the wrist

did not subside, she was sent in January, 1922, to the out-patient department of the Royal Infirmary. Radiographs (*Fig. 181*) taken on Jan. 25 show the myeloma involving the lower third of the radius. The growth extends downwards almost as far as the epiphysial line, and has actually penetrated its bony shell and invaded the periosteum in two places.



FIG. 181.—Radiographs of the right lower forearm, anteroposterior and lateral views. At *x* and *y* the myeloma has perforated the thin bony shell.

### OPERATION.

On Feb. 3, 1922, the lower portion of the radius was removed, leaving the epiphysis intact. The periosteum was left *in situ*,

except at the two points where it had been invaded by the growth. A bone-graft of the size and shape shown in *Fig. 182* was cut from an ox tibia the day before the operation, and boiled for half an hour before insertion. The upper end was pushed into the medullary cavity of the radius, as shown in the illustration, and the periosteum was sutured round the graft. The arm was bandaged on a splint until the skin sutures were removed. It was then put up in plaster. *Fig. 182* shows the graft *in situ* on the second day after the operation. Radiographs taken respectively two, four, and fifteen months after the operation are shown in *Figs. 183, 184, and 185*. *Fig. 185* shows the graft completely absorbed and the radius restored. The radius is not growing at the same rate as the ulna, and this accounts for the radial deviation of the hand.

The patient was encouraged to use the fingers and thumb from the start, and the plaster splint was discarded three months after the operation.

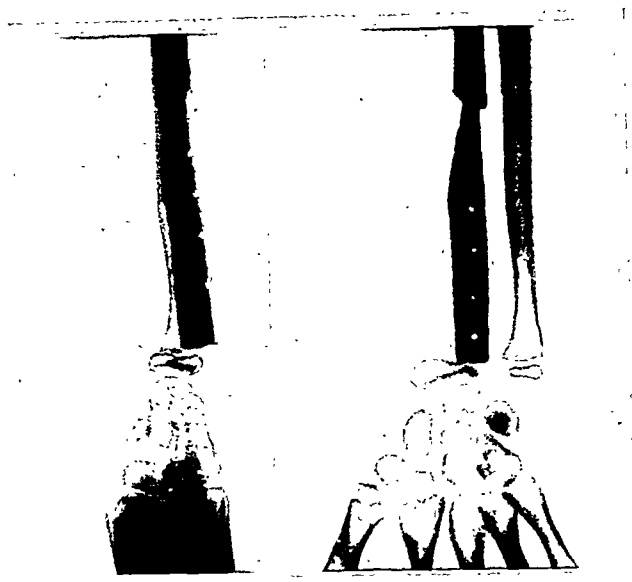


FIG. 182.—Radiographs taken two days after the operation. The somewhat pointed upper end of the bone-graft is visible in the medullary cavity of the radius.

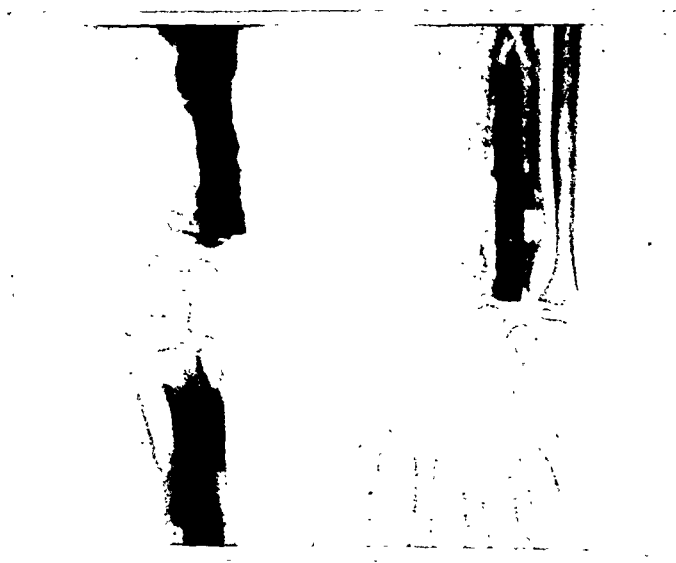


FIG. 183.—Radiographs showing the condition two months after operation. A marked formation of callus has occurred, and the graft is undergoing absorption.

Movements were very little affected at any time, and now, in spite of the radial deviation of the hand, are practically normal. It may be found necessary to remove a part of the ulna to compensate for the slow growth of the radius; but at present it is doubtful if the functional value of the arm could be improved by any operative treatment.



FIG. 184.—Radiograph of the lower forearm four months after operation. Note the extensive callus. The remains of the bone-graft are darker in appearance than is the newly-formed bone.

### MICROSCOPIC APPEARANCE.

Our histological examination deals with: (1) *The structure of the tumour itself*; (2) *The boundary zone between tumour and bone or tumour and marrow*; and (3) *The marrow beyond the myeloid expansion*. We shall describe the histological features of these regions separately.

1. **Histology of the Tumour.**—The growth appears to replace the normal marrow; it consists of spindle cells each with an oval or elongated nucleus, and exhibits here and there throughout the myeloma, particularly numerous near the periphery, large giant cells. In the ordinary red myeloma the colour is explained by the presence of hæmorrhagic extravasations of large size and regions highly vascularized. In the white variety, extravasated blood and vascularized areas are of less frequent occurrence. The concentration of the spindle cells is not uniform, a fasciculated



FIG. 185.—Radiographs taken fifteen months after operation. The regenerated lower third of the radius exhibits radial deviation. The bone-graft has disappeared entirely.

appearance being observable; in a groundwork of loosely scattered cells there appear to be areas of closely-packed spindle cells usually surrounding giant cells: the probable explanation being that spindle cells arise in the dense areas and invade those where there are few cells or none. No signs of mucoid degeneration are observable. Megakaryocytes having a typical annular nucleus, and myelocytes normally present in marrow, are absent. Although the marrow is entirely replaced, there are still some bone trabeculae to be seen. Many of these show necrotic changes. The trabeculae are the remains not only of the spongy bone at the end of the radius but also of the peri-medullary bone, the absorption of which keeps pace with the growth of the tumour. There is still a shell of bone, perforated in places, around the myeloid growth beneath the periosteum. A description of a white myeloma has been given by Stewart.<sup>1</sup> The tumour which he describes is also at the lower end of the radius. With most of the histological details given by him we are in agreement, although we consider that the tumour is not a mixed-(mainly spindle-) cell sarcoma as stated by him, but is composed entirely of giant cells and spindle cells, 'small or round cells' being absent. It is probable that what we conclude are spindle cells cut transversely were described as 'mixed' cells by Stewart. This conclusion is supported by the observation that where bundles of spindle cells are cut longitudinally no cells resembling 'small cells' are visible. Hence the accounts of a myeloid sarcoma (or giant-cell sarcoma)—not necessarily of the white variety—given by Macallum<sup>2</sup> and Ewing<sup>3</sup> more closely coincide with our interpretation of the structure of the tumour.

*Cytology of the Spindle Cells.*—The cells which form the bulk of the tumour vary in size and shape. In some regions they are elongated and arranged in bundles, and in these the nucleus is also elongated and often stains deeply; in other regions the cells are shorter and the nuclei oval. In all cases the nuclear membrane is well defined, and within the nucleus are two prominent karyosomes as well as scattered granules of basichromatin. The nuclei vary in length from 11 to 16  $\mu$  and in width from 3 to 6.5  $\mu$ . We observed a great similarity in the nuclei of the spindle cells, osteoblasts, osteoclasts, and giant cells; in some cases the spindle-cell nuclei are more elongated, and in other cases they appear swollen; but with respect to nuclear membrane, karyosomes, and chromatin particles there is little or no difference. It has already been mentioned that blood extravasations and vascular areas are present in both grey and red varieties of myeloma, but especially in the latter. Some extravasations and blood-vessels contain blood only, others are being invaded by spindle cells. That a migration of spindle cells occurs from the tumour into the vessels and extravasations, and not in the reverse direction, is clearly indicated in our sections. Of these invading spindle cells, those nearest the margin of the blood-spaces closely resemble the ordinary cells of the myeloma; those which have penetrated into the spaces have more elongated, thinner, deeper-staining nuclei and fusiform outline. Some others are rounded or angular.

*Giant Cells.*—Unquestionably the most interesting elements in the myeloma are the giant cells. These are found throughout the tumour, but are very numerous near the periphery. Where the spindle cells are most plentiful and



concentrated, viz., in the deeper parts of the myeloma, the giant cells are rare. As we have already stated, those giant cells present within the myeloma are usually surrounded by fasciculi of densely-packed spindle cells. Typically the cytoplasm of the giant cell is markedly eosinophil and counterstains readily with eosin; thus the giant cells contrast with spindle cells, the cytoplasm of which is not eosinophil in reaction. This property is not constant, however, and the cytoplasm of some giant cells shows gradations in colour from intense

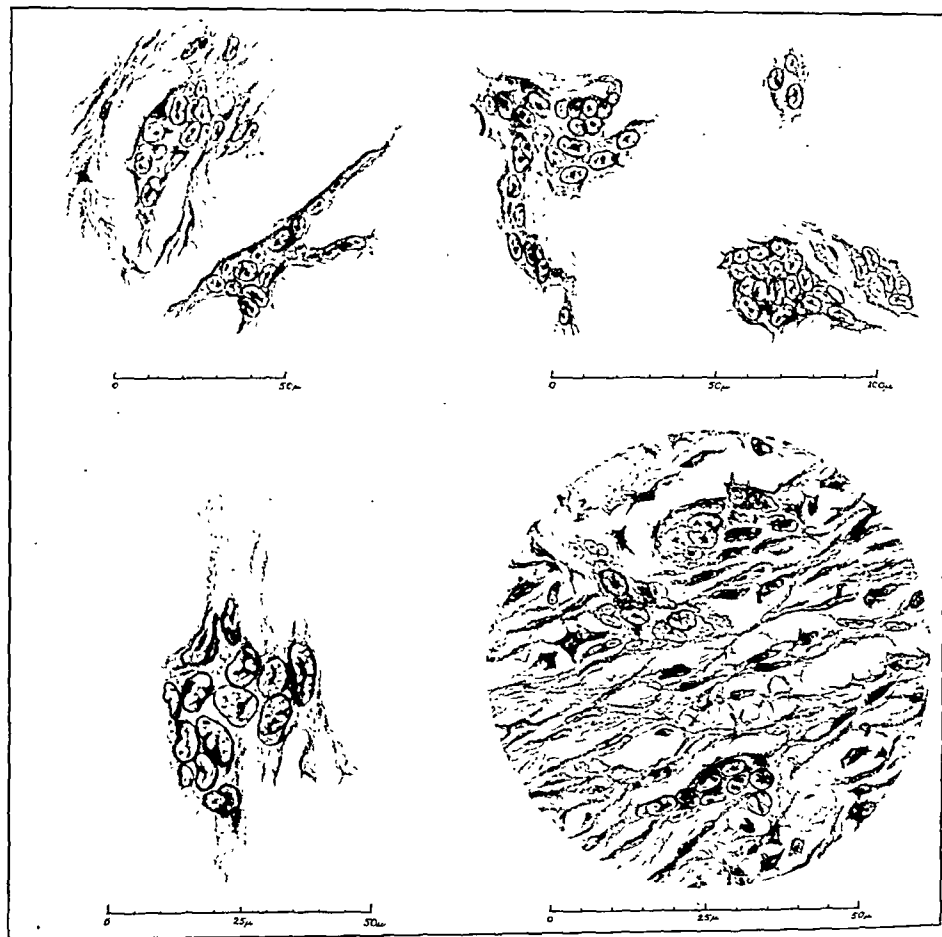


FIG. 186.—Giant cells of the myeloma drawn under high power. There is great variation in size, shape, and number of nuclei. The nuclei of some spindle cells shown in the lower right-hand figure resemble the giant-cell nuclei.

pink to that assumed by the cytoplasm of the spindle cells. The number of nuclei present in the giant cells varies considerably (see Fig. 186), from two or three up to twenty-four and more. As we have counted at least twenty-four in some cells it is safe to conclude that this number is greatly exceeded in many cases, when it is remembered that we are examining thin sections and that some giant cells attain dimensions greater than the thickness of a section.

The nuclei of the giant cells so clearly resemble those of the spindle cells, both in the possession of well-defined nuclear membrane and two karyosomes, and also in size, that we have measured a great many for comparison. They average about  $13\ \mu$  in length and  $5\ \mu$  in diameter, though some few very elongated nuclei attain a length of  $18\ \mu$ . As stated above, the spindle-cell nuclei vary in length from  $11$  to  $16\ \mu$ , and in width from  $3.5$  to  $6.5\ \mu$ . There is the same variation in the outline of the giant-cell nuclei (from oval to spindle form) as occurs in the spindle-cell nuclei.

The size and shape of the giant cells vary as much as does the number of their nuclei. The giant cells with two or three nuclei are only distinguishable from spindle cells by the multinucleate condition, their nuclei being similar and their cytoplasm not eosinophil (*Fig. 187*). In very many cases the giant cells have long processes in which nuclei

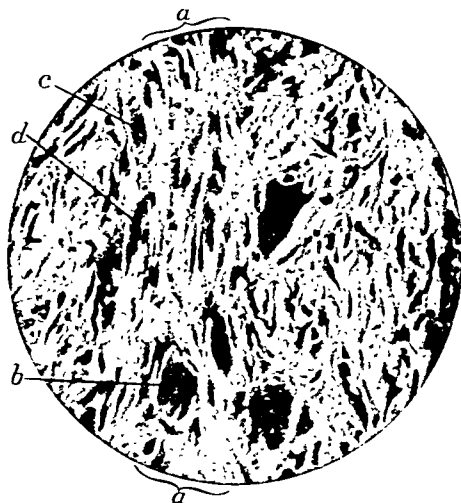


FIG. 187.—A portion of the myeloma containing giant cells. *aa*, Fasciculus of spindle cells produced from the giant cells shown. The one *b* presents a stage of fragmentation; another (*c*) is still smaller; while that at *d* is difficult to distinguish from a group of spindle cells.



FIG. 188.—Two giant cells highly magnified. Note the curious arrangement of the nuclear chromatin in the cell on the left.

(one or more) are present (*Fig. 186*); often these processes, or a considerable portion of the margin of a giant cell, merge imperceptibly into the surrounding spindle cells, so that it is difficult or almost impossible to define the margin of the giant cell. Some giant cells occur in groups, the cells in some cases being so closely contiguous that we have reached the conclusion that the appearance indicates a fragmentation of a giant cell into smaller cells (*Figs. 186 and 187*). Vacuoles (one or more), some containing leucocytes, are visible in many of the giant cells. Sections stained with Leishman or Giemsa clearly demonstrated the phagocytic character of these giant cells, red as well as white corpuscles having been ingested.

In addition to the giant cells with resting nuclei, there are a few—presumably giant cells—with nuclei

exhibiting karyokinetic changes such as are usually associated with protozoa (*Fig. 188*). The nuclei of the cell to the left side of *Fig. 188* appear to have a nuclear membrane with chromatin attached to it. To the right side of *Fig. 188* the resting nuclei of a giant cell are shown for comparison. Howard<sup>4</sup> has described giant cells with nuclei which show protozoan characters. We do not propose to deal with the significance of these nuclear appearances until we have further investigated them.

Another interesting variety of multinucleated cell is depicted in *Fig. 189*. The cytoplasm is strongly eosinophil, and the nuclei (eleven of which can be seen in the figure) are much smaller than are those of the ordinary giant cell (3 to 4  $\mu$ ), and moreover stain intensely and uniformly. The microphotograph is of a cell magnified to the same extent as the giant cells seen in *Fig. 188*. We are disinclined to believe that a cell such as the one shown in *Fig. 189* is a giant cell in the pyknotic condition.

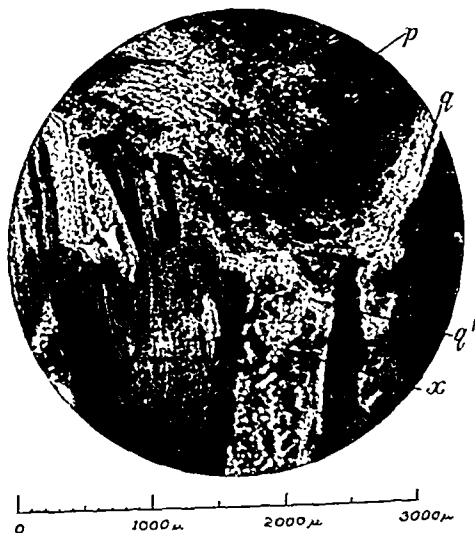
Beyond a brief reference to these cells, which may have an important rôle in the etiology of the tumour, we defer consideration of their significance until we have examined additional material.

Giant cells are numerous in the neighbourhood of blood-spaces; but not frequently, in fact rarely, do they appear in the vessels or extravasations. Where spindle cells are invading blood-spaces the giant cells are usually small, and most probably fragmenting to give rise to spindle cells. We have seen nothing to indicate that the giant cells have an angioblastic origin, and no evidence that the giant cells are brought to the tumour in the blood-stream.

**2. Histology of the Region between the Myeloma and Subperiosteal Bone or Bone-marrow.**—In this region, marked *q* in *Fig. 190*,



**FIG. 189.**—A multinucleate cell in the myeloma with small deeply-staining nuclei and eosinophil cytoplasm. A portion of the latter (*m*) containing two nuclei is becoming detached from the main mass. Another uninucleate cell probably derived from the large cell is seen out of focus at *n*.



**FIG. 190.**—Longitudinal section of radius including the lower end of the myeloma (*p*), the intermediate zone (*q*), and the normal marrow (*x*).

there are for the most part numerous blood extravasations in which are seen, in addition to the formed elements of the blood, a great many giant cells or osteoclasts. We use the terms synonymously, because there is no structural character which can be applied whereby the giant cells of this tumour may be distinguished from the numerous osteoclasts also present. With regard to variability in dimensions, contour, and staining reaction, and the number, size, shape, and structure of the nuclei, we find no marked difference between giant cells and osteoclasts; only in cases where a multinucleated cell was in close relation to the bone, e.g., in a Howship's foveola, could we with certainty consider the cell as an osteoclast and not a giant cell. It follows therefore from this last statement that the giant cells in the myeloma may be osteoclasts which have ceased to function as bone-destroyers. Our observations on this point have led us to conclude that the giant cells in a myeloma of the epulis type are, or are derived from, osteoclasts.

In the zone between bone and tumour there are in places bone trabeculae surrounded by numerous, apparently normal, active osteoblasts; in other places osteoclasts are engaged in destroying the bone which the osteoblasts are producing (Fig. 191). There is no doubt that the bone trabeculae and the subperiosteal bone are removed by osteoclasts which are not only abnormally large but also abnormally numerous, the subperiosteal bone becoming first cancellous and later reduced to trabeculae ever diminishing in size. Owing to the progress of the myeloma, these trabeculae become incorporated within it, and later undergo necrosis. Since the

osteoclasts are not numerous in the normal marrow adjoining the tumour, and are in our opinion not carried to the tumour by the blood,

the most reasonable assumption is that they are formed in great numbers at the boundary between bone and tumour. The nuclei of the osteoclasts vary between  $11\mu$  and  $8\mu$ ; those of the osteoblasts also range from  $8$  to  $11\mu$  in length. Erythrocytes in these sections are about  $6\mu$  in diameter, so the measurements quoted above are probably somewhat lower than those for the fresh unfixed cells. The close similarity in size and structure which exists between the nuclei of osteoblasts and osteoclasts favours the view that the latter are produced by a fusion of the former. The possibility of osteoclasts being derived from marrow is more than doubtful, since there are no tissue-cells in marrow with nuclei at all comparable with those of the osteoclasts. Some trabeculae in this region are covered with osteoblasts,

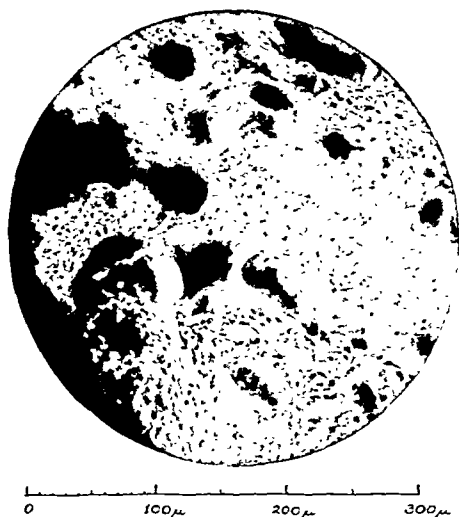


FIG. 191.—A portion of the intermediate zone between myeloma and bone showing the numerous osteoclasts or giant cells. On the extreme left is the bone (black).

which in places appear to be undergoing fusion. The change which is occurring at the boundary of the tumour is not apparently due to a deficiency of osteoblasts, but to a disproportionately large number of osteoclasts. Furthermore, many of the osteoclasts in this region are surrounded by spindle cells, and in some cases the former appear to be fragmenting to give rise to the latter.

In the region marked  $q'$  in *Fig. 190*, where growth is proceeding towards the epiphysial line, an invasion of the marrow by giant cells and spindle cells is observable, so that beyond the myeloma towards the marrow there is an intermediate or boundary zone consisting of giant cells, spindle cells, marrow elements, and blood. Beyond this again normal marrow is found.

**3. Histology of the Marrow beyond the Boundary Zone.**—There is nothing noteworthy about the marrow beyond the intermediate zone.

### DISCUSSION.

It is probable that a myeloid sarcoma is produced by the formation in abnormal numbers, by the fragmentation later, of osteoclasts which remove the bone very quickly; in consequence the bone becomes thinner and thinner until it (and the periosteum overlying it) is pierced, and the tumour-cells invade neighbouring tissues. Radiographs of the lower third of the affected radius demonstrate the thin shell of bone surrounding the growth: the diameter of the diaphysis in this region is distinctly greater than that in the normal diaphysis (*Fig. 181*). This increase can only be accounted for by supposing (1) that subperiosteal bone is deposited abnormally quickly beneath the periosteum, and (2) that the bone nearest the marrow cavity is absorbed or destroyed even more quickly by irregular osteoclastic activity.

The transitional zone affords most evidence of the probable origin of the tumour, since histologically it differs less from the normal than does the myeloma; in this zone the abnormal features are the excessive number of osteoclasts, the presence of spindle cells (not as concentrated as in the myeloma, but anticipating the condition of the latter), and the reduction in the number of fat-cells and other constituents of marrow. Perhaps the condition which is primarily responsible for the excessive formation of osteoclasts is the chief, if not the only, etiological factor in the origin and growth of the myeloma. These cells are produced normally at first to remove calcified cartilage, and at a later stage in bone-development to remove bone (both trabecular and periosteal), whereby the marrow-cavity is increased in size; the ratio between thickness of diaphysis and diameter of marrow cavity is maintained within certain limits, which are an expression of greatest efficiency and strength of the bone, having regard also to economy of material. On functional grounds, therefore, it is legitimate to compare osteoclasts with 'foreign'-body giant cells: both are employed in removing material which is useless, or a hindrance to optimum development, and thus 'foreign' in the metabolism of the body. The conditions normally determining the formation and activity of the osteoclasts are not known. It may be that physical stresses in the bone are responsible, in the same way as they are responsible for the arrangement of the trabeculae at the end of a long bone, as well as for the protuberances of bones.

With regard to the cause of origin of a myeloma, the following are possible explanations: (1) A local injury to the periosteum (e.g., trauma caused by a blow) may result in hypertrophy of periosteal bone, and to preserve the ratio of thickness of bone shaft to diameter of marrow cavity an abnormal number of osteoclasts are produced. (2) There may be some change of metabolic origin resulting in the existing bone becoming altered in chemical composition and thereby calling into existence osteoclasts to remove it. (3) Some agency may cause a local change whereby the osteoclasts are abnormally increased in number: stimulation of osteoclasts to form, or, if formed, to multiply to excess, may result from the presence of a foreign body, parasite, or even wandering cells from some other part of the body. The following appear to us to be objections to (1) above. The infrequency of incidence of myeloid sarcoma as compared with the frequency of cases of bone injury seems to imply that some other attendant factor must be assumed if we are to attach much weight to this view; the injury would affect the subperiosteal lamellæ of bone more than the perimedullary; why, therefore, should the latter be removed at all? The chief objection to (2) is that a metabolic change would most likely be attended by a generalized pathological condition, and not one localized as is usually the case in myeloma. The few cases of multiple myeloma which occur can be satisfactorily explained by (3). On the whole, therefore, a local abnormal stimulation of osteoclast formation or of osteoclast division, whether auxetic, kinetic, or katabolic, seems to us the most probable explanation of the presence of large numbers of osteoclasts or giant cells at the periphery of a benign epulis. That it is not the presence of the spindle cells which is responsible for the giant cells is clear when we recall the distribution of the latter: i.e., few in the centre, where the spindle cells are most abundant, and numerous at the edge of the growth, where the spindle cells are comparatively scarce. Clinical evidence appears to favour (3), viz., that owing to some localized condition osteoclasts are formed in great numbers; in other words, a condition is created favouring the formation of osteoclasts.

**Origin and Structure of Giant Cells and Osteoclasts.**—Two kinds of giant cells in myeloma have been described—the true and the false. According to Poncet,<sup>6</sup> the former are as large as three or four ordinary spindle cells, and contain five or six nuclei; the latter are rather larger and contain twelve to twenty nuclei; the 'false' giant cells are very numerous in the benign epulis. Borst drew a distinction between giant cells of medullary sarcoma and those of periosteal origin: he accepted a multiple origin for giant cells. Mallory<sup>7</sup> distinguished true tumour giant cells (which may multiply by mitosis) from foreign-body giant cells (of bone and other sarcomas) represented in the epulis type of sarcoma; the former differ chiefly in size and number of nuclei from the latter, which are transformed wandering endothelial leucocytes not produced in the tumour. Virchow and Rindfleisch<sup>8</sup> believed that, when bone-matrix is absorbed, the osteoclasts set free produced giant cells of the epulis type: thus they identify giant cells with osteoclasts. Robin<sup>9</sup> and Nélaton<sup>5</sup> took the same view. Wyss,<sup>10</sup> Ziegler,<sup>10</sup> and others trace the origin of giant cells in sarcoma to bone-forming cells; Ziegler suspected that osteoclasts might not all originate in the same way. Wegner,<sup>10</sup> Malassez,<sup>11</sup> Ritter, and later observers have reached the conclusion that giant cells of the epulis type are

derived from modified endothelium and are therefore of angioblastic nature. Ewing<sup>3</sup> considers that it is necessary to recognize in morphology and origin two types of giant cell in bone sarcoma. The type most common in benign epulis is chiefly of endothelial origin, and is a foreign-body giant cell which does not participate in the tumour process; the other type is derived from the tumour-cells, and occurs chiefly in malignant tumours of the *periosteum*. We consider that divergence of opinion upon the question as to whether there is more than one kind of giant cell in benign epulis is explained by the fragmentation process which these giant cells undergo; the gradations in character of the giant cells are similarly explained. The multinucleated cell shown in *Fig. 189* does not correspond with either of the types mentioned above.

Various other sources of origin of osteoclasts have been suggested: e.g., marrow mesenchyme, cells of the *periosteum*, connective-tissue cells carried by the blood to the medullary cavity may be cited to illustrate the uncertainty of our knowledge on this interesting problem.

Since these multinucleated cells are present wherever bone is to be removed, or, as in the case of the milk teeth, where the roots are to be absorbed, it is not unreasonable to postulate that they have an origin *ad hoc*, and that they are formed in a similar way to other foreign-body giant cells. Judging from our sections, we should unhesitatingly conclude with Kölliker and others that the osteoclasts are derived from the osteoblasts, for the following reasons: the great similarity in appearance, size, and staining reaction of osteoblast nuclei and the nuclei of an osteoclast; the fact that the two kinds of cells are always associated; that where an osteoclast is found against a bone, osteoblasts are absent; and the occurrence sometimes observable of osteoblasts apparently fusing together. In the myeloma we have described, the osteoclasts are very numerous at the periphery of the tumour nearest the bone; they are not so numerous where the tumour and marrow are continuous. We therefore favour the views of Kölliker that osteoclasts are derived from osteoblasts and ultimately break up into osteoblasts. Virchow, Rindfleisch, Robin, and Nélaton came to the same conclusion. Lambert's<sup>12</sup> work on the cultivation of the spleen of the chick in plasma indicates that spleen-pulp cells may fuse to give rise to giant cells. Thus this function is not confined to endothelial cells or to lymph-cells.

**Formation of Spindle Cells.**—The osteoclasts produced in great numbers do not, in our opinion, confine their attention solely to bone removal. The histological evidence appears to indicate that while some destroy the bone, others become phagocytes upon the elements of the marrow, viz., myelocytes, fat-cells, red and white blood-corpuscles, etc., and thus account for the absence of the normal constituents of marrow in the myeloma. We observed many giant cells which contained in their protoplasm other cells. Other giant cells presumably lose their osteoclastic function and undergo a process of dedifferentiation, i.e., they fragment into smaller and smaller cells until the uninucleate spindle-cell condition is arrived at, the original osteoclast nuclei becoming elongated and swollen in the process (*Figs. 187, 192, 193*). Similarly nuclei of cells undergoing dedifferentiation in tissue cultures become slightly swollen. The following is a summary of the evidence in favour of this view: The giant cells or osteoclasts in the myeloma are most numerous at the margin;

they vary in size, shape (many are elongated and have processes—*Fig. 186*), and number of nuclei (from twenty-four and upwards down to two); their cytoplasm exhibits gradation in its affinity for eosin—the giant cells with only a few nuclei have cytoplasm which resembles that of the spindle cells in not staining with eosin; the close resemblance between osteoclast and spindle-cell nuclei; the signs of fragmentation of many giant cells; and the difficulty of determining the boundary of some giant cells. To these we may add, in support of the view that the spindle cells are formed *in situ* and not brought by the blood, the fact that the blood-spaces have in them at first no spindle cells, but become invaded by them later; although some spindle cells are seen to be undergoing mitosis and possibly also direct division, the absence of any marked mitotic or amitotic division of



FIG. 192.—Giant cells undergoing fragmentation.



FIG. 193.—A group of giant cells arranged in such a way as to suggest that the larger cells divide up into smaller cells with fewer nuclei. At *a* some osteoblasts are visible. Their nuclei closely resemble the nuclei of the giant cells.

any dedifferentiation of the cells will nucleate cells to produce cells with

the spindle cells seems to exclude the possibility of any appreciable tumour growth in this way. Finally, the clinical evidence that growth of a myeloma is most rapid laterally, viz., in the neighbourhood of the bone where the osteoclasts are formed, rather than, as one would expect, along the line of least resistance, viz., the marrow cavity. The earliest stage of the disease has been traced by some writers to the walls of small 'cysts' or cavities which form in osteitis fibrosa cystica. Such an origin is not inconsistent with an osteoclastic fragmentation resulting in tumour formation.

Although fragmentation of cells in the manner described above is not known to occur in normal cell-division, yet when we recollect how these giant cells probably arise, viz., by a fusion of uninucleated cells, it is not unreasonable to predict that begin with a division of the multi-nucleated cells. Carleton<sup>13</sup> defines



dedifferentiation as "the return of previously specialized elements to a simpler and more embryonic type"; it is the reverse of differentiation—"the process of specialization, functional and structural, of cells and tissues". Champy<sup>14</sup> describes how, in tissue cultures of non-striated muscle-cells of the urinary bladder, the cells become swollen, lose their myofibrils, and cease to show any of the characteristics of the previously highly differentiated muscle-cells. Complete dedifferentiation to an indifferent condition occurs, and the resulting cells approximate in appearance to the undifferentiated cells of the early embryo.

Champy<sup>14</sup> also was the first to notice that in tissue cultures some of the cells ingest phagocytically other elements present. Thus in testis cultures the Sertoli cells first agglutinate and then ingest the spermatocytes. We have mentioned that the giant cells ingest other cells; this may be explained

as the normal function of these cells, indeed their *raison d'être*. It is perhaps not without significance that whereas many observers have noted the phagocytic properties of the giant cells in myelomata, histologists are far from unanimous with regard to whether osteoclasts ingest bone or destroy it by producing an enzyme. If this difference in function exists between osteoclasts and giant cells, it may be cited against our view that the osteoclasts are the giant cells in a benign epulis. On the other hand, the phagocytic function assumed by the osteoclasts is characteristic of some dedifferentiating cells.

Yet another question of interest is the influence of environment on tumour-cell outline. It has been mentioned above that, where an invasion of a blood-space occurs in

the myeloma, the cells in the blood are usually fusiform with elongated nuclei, though others appear to be small and round. At the periphery of the space the invading cells have more oval nuclei, like the great majority of the tumour-cells. This observation is in accordance with the findings of Uhlenhuth<sup>15</sup> for tissue growth in culture—the growth in a semi-hard medium was effected by fusiform cells migrating individually into the surrounding plasma.

Since these observations were made, we have read Carleton's admirable critical summary of tissue culture,<sup>13</sup> and we cannot refrain from noting the parallelism which in our opinion exists between the behaviour of the cells producing the myeloma, and certain established phenomena in cultures of

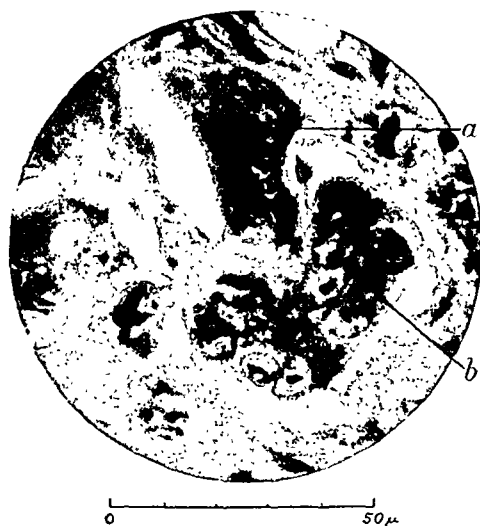


FIG. 194.—The giant cells referred to in Fig. 193 under higher magnification. One smaller cell at *a* is just about to separate from the main mass *b*; the separation is not yet complete.

tissue, viz., dedifferentiation and phagocytosis. In dealing with the application of tissue culture, Carleton asks this question, "Are the factors which produce dedifferentiation on the part of specialized tissues *in vitro* the same as those which produce the formation of malignant tumours *in vivo*?" The evidence which we have given bearing on the formation of the benign epulis indicates that the factors may be the same. Although we do not contend that the method of formation of a giant-cell myeloma is a prototype whereby the formation of malignant growths may be explained, it is sufficient at this stage to observe that many tumours apparently benign may later become malignant.

### SUMMARY AND CONCLUSION.

1. The giant cells in a benign epulis or giant-cell myeloma appear to be derived from osteoclasts.
2. The removal of the marrow by giant-cell phagocytosis and the formation of the tumour cells by fragmentation of giant cells may be likened to the dedifferentiation changes which occur in certain cells in tissue cultures.
3. A few giant cells were seen in the myeloma with nuclei exhibiting an uncommon type of karyokinesis which is associated with some protozoa.
4. Some few other multinucleate cells with small nuclei and strongly eosinophil cytoplasm were seen : observations upon these are being continued.

We are indebted to Professor R. C. McLean for kindly permitting us to use the photomicrographic apparatus in his department ; also to Miss M. White for the drawings in *Fig. 186*.

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## PLEXIFORM NEUROFIBROMA OF THE SOLAR PLEXUS.

By HERBERT A. BRUCE, TORONTO.

ONE of the most valuable contributions to the subject of tumours of nerves was that made by Mr. Alexis Thomson,<sup>1</sup> Professor of Surgery in the University of Edinburgh, in a monograph on neuroma and neurofibromatosis, published in 1900.

The term 'neuroma' was introduced by Odier, of Geneva, in 1803, to designate "tumours formed by diseased enlargements of the nerves". William Wood,<sup>2</sup> of Edinburgh, discussing the origin of neuromata in a paper in the transactions of the Medico-Chirurgical Society of Edinburgh in 1829, believed them to originate from the connective-tissue sheaths of the nerve, and not from the nerve tissue itself. He remarked upon the inefficacy of medicines, and recommended removal of the tumour by operation. Amongst others he quoted a case from the *Encyclopédie Méthodique de Chirurgie* (Paris, 1792) in which amputation was performed for what was undoubtedly a plexiform neurofibroma of the median nerve of the forearm. Smith, of Dublin, in his classical work on neuromata in 1849, considered that the mere anatomical connection of a tumour with a nerve was sufficient to regard it as a neuroma, whatever its structure might be. However, Virchow, in his lectures published in 1863, placed the pathology of neuromata on a new basis, by classifying them on a structural instead of a clinical basis, and dividing them into the true and the false—the former composed mainly of new nerve tissue, the latter (pseudo-neuroma) of connective tissue derived from the sheaths of the nerve. True neuromata are very rare, but several authentic cases have been recorded.

Attention is called to the present case of plexiform neurofibroma of the solar plexus, not only because of its inherent interest and rarity, but because it has to be taken into consideration in a differential diagnosis of abdominal tumours: however, as I am only able to find one other case of plexiform neurofibroma affecting the solar plexus in the literature, one given by Bruns,<sup>3</sup> it will not be necessary to work out elaborate methods for its detection.

J. K., age 35, referred to me by Dr. R. J. MacMillan, gave a history of having been injured in a fall at the age of 18. He had never had any serious illness until an attack of influenza four years ago which confined him to bed for three months. Since that time he has had constant pain in his back in the right lumbar region, accompanied by tenderness on deep pressure, usually relieved by a belladonna plaster. At irregular intervals, increasing of late, this pain in his back would be so severe as to confine him to bed for several days, and was generally regarded as lumbago. When free from these attacks he had a good appetite, appeared to be in good health, although always very thin, and carried on his usual work. The tumour became palpable about three months before I saw him. Two months ago he suffered from lenteric

diarrhœa, which cleared up on milk diet. For the last few weeks he had not been able to retain any solid food, and had even vomited most of the fluids given. When he entered the hospital his urine was found to contain diastase. Examination of the abdomen disclosed a tumour about the size of a grape-fruit in the mid-epigastric region, only very slightly movable from side to side. It felt solid, and had a tympanitic note over it. The abdomen otherwise was very thin, tense, and emaciated. There was no pigmentation of the skin, and no nodules were seen in any other part of the body.

An X-ray examination was made by Dr. H. M. Tovell, who reported as follows :—

There is no definite radiographic evidence of a pathological condition in the stomach or bowel which would indicate ulceration or malignancy. There is evidence that a mass external and posterior to the stomach is pressing upon the lesser curvature and also upon the transverse colon. From the position of the mass one would be suspicious of the pancreas; yet there is no evidence of displacement of the duodenum, which assumes the usual relation to the stomach, which one would think would not be the case if a pancreatic tumour were present.

However, a diagnosis of 'tumour of the pancreas' (probably a cyst) was made, and it was thought that the injury referred to above might have been a causative factor. Under anæsthesia the tumour, which was very hard and nodular, could be moved freely from side to side, and to a less extent from above downwards. On making the incision, the transversalis fascia was found tightly stretched over the tumour, and when it and the peritoneum were divided, the tumour popped out as if under great pressure. It was then seen to press forward the gastrohepatic omentum and the stomach, which was tightly stretched over it. The pylorus, which was lying in the middle line, was widely dilated, as were also the first and second portions of the duodenum. The glands along the greater and lesser curvatures were not involved. The tumour mass was about the size of a grape-fruit, distinctly nodular, and appeared to be connected with the pancreas. Thinking it malignant and inoperable, after removing a couple of nodules for microscopical examination, the abdomen was closed, but with considerable difficulty.

We were surprised at receiving a report from the pathologist that the section was a myoma. In view of these findings, and the fact that the patient was unable to retain any nourishment owing to the mechanical effect of the tumour in shutting off the outlet of the stomach making a fatal result inevitable in a very short time, we decided to try to remove the tumour. The former incision was re-opened twelve days later, and a thorough examination of the tumour, both through the gastrohepatic omentum and the transverse mesocolon, revealed it lying behind the pancreas, which was not involved. A good deal of difficulty was met with in dissecting out the growth, as a number of very large blood-vessels coursed through it. The mass looked a little like a thick tapioca pudding, with a fine mesh of fibrous tissue stroma between the little nodules. The patient recovered nicely from the immediate effects of the operation, and the same evening his pulse was good and his condition seemed satisfactory. However, he died suddenly the next morning, probably from pulmonary embolism.

I am indebted to Dr. G. W. Loughheed, Pathologist to the Wellesley

Hospital, for the careful dissection and examination of the tumour, and the following report :—

*Gross Specimen.*—Consists of a large tumour mass which is growing in an irregular fashion. There are a large number of grape-like masses projecting from the inner surface of this tumour. They are firm in consistency, whitish in colour,

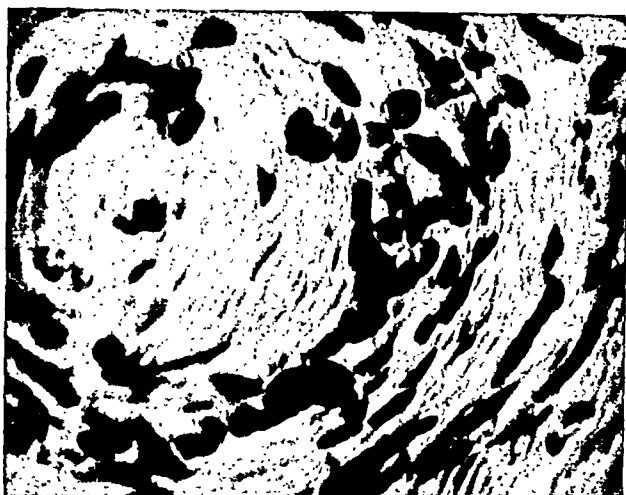


FIG. 195.—Microphotograph showing whorl formation of non-medullated nerve fibres. High dry power  $\times 10$  eye-piece ( $\frac{2}{3}$  scale).



FIG. 196.—A, Dissected portion of tumour showing plexiform arrangement of neurofibromata. B, Cross-section of dissected portion. C, Undissected portion of tumour. Gross tumour measures  $5 \times 3 \times 2\frac{1}{2}$  in. The illustration represents about one-tenth of the tumour, and the nodules are natural size.

and on section have a slight tinge of green. The remainder of the tumour is red in colour, and appears to be covered with a firm thin sheet of fibrous tissue. Beneath this are more of these grape-like masses.

*Microscopic Findings.*—Slides of some of these nodules show them to be made up of a loose areolar connective tissue with numerous nerve bundles running through

it. There is a fair amount of collagen material present, and in places the tissue is rather œdematous in character. There is no evidence of ganglion nerve-cells present. The majority of the tumour is made up of non-medullated nerve fibres intimately surrounded by fibrous tissue. (*Figs. 195-198.*)

*Diagnosis.*—Neurofibroma (plexiform).



FIG. 197.—Section of one of the nodules showing nerve bundle present, with surrounding loose areolar connective tissue. Low power  $\times 5$  eye-piece ( $\frac{2}{3}$  scale).

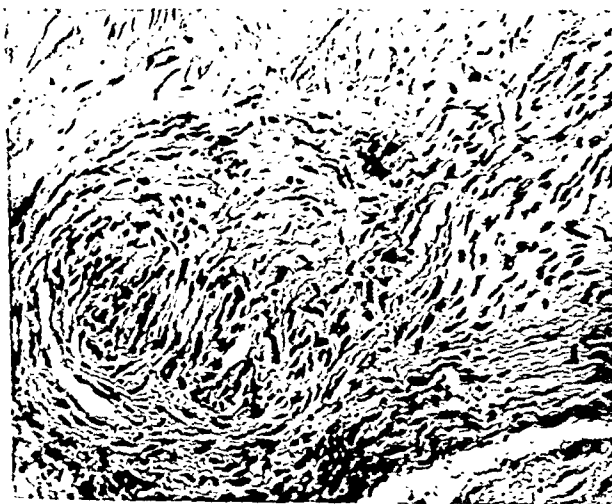


FIG. 198.—Demonstrating whorls of non-medullated nerve fibres, surrounded at top of picture by well-formed fibrous tissue. Low power  $\times 10$  eye-piece ( $\frac{2}{3}$  scale).

The plexiform is the most interesting type of neurofibromatosis. It is a fibromatosis confined to one or more contiguous nerves or a plexus of nerves. The lesion is the same as the more generalized form of neurofibromatosis,

and the two conditions may be met with in the same individual. Although rare, Bruns collected 42 cases, and Thomson 18, which with 2 of his own make a total of 62. It is stated that the tumour may undergo degeneration and may even disappear (Baumgarten), but Thomson agrees with Goldmann that such changes are altogether exceptional. A peculiarity of the plexiform type is the tendency, although involving a purely sensory nerve, to penetrate the adjacent muscles. There may be an overgrowth of subcutaneous tissue and skin in relation to a plexiform tumour which is best described by the term 'elephantiasis', where the skin frequently shows excess of the normal pigmentation. By far the most frequent situation of plexiform neurofibromatosis is the subcutaneous tissue of the head and neck—in the distribution of the trigeminal and superficial cervical nerves—although it may be met with anywhere throughout the sympathetic and peripheral cerebrospinal systems.

The following table is given by Bruns, with additions collected by Thomson :—

#### SITES OF PLEXIFORM NEUROFIBROMA.

Temple, forehead, and upper eyelid	..	..	18 cases
Posterior part of neck and behind auricle	..	..	14 "
Nose and cheek	..	..	4 "
Region of lower jaw, and anterior half of neck	..	..	5 "
Breast and back	..	..	8 "
Extremities	..	..	9 "

The nerves of the extremities include the median, musculospiral, radial, and small sciatic. Goldmann and Pomorski have each recorded a case in which the intercostal nerves were affected, the tumour projecting into the pleural cavity. Bocasso observed a tumour below the jaw, passing along the hypoglossal nerve into the substance of the tongue. Bruns drew attention to the fact that the most common seats of the plexiform neurofibroma are also the most common situations of elephantiasis neuromatosa or pachydermatocele, with which it is frequently associated.

Plexiform tumours are found coexisting with a generalized fibromatosis and with multiple skin-fibromata (molluscum) in about 50 per cent of cases.

Plexiform neurofibroma resembles the elephantiasis with which it is commonly associated, inasmuch as it may be present at birth or develop in early infancy. As to the influence of heredity, a study of the cases demonstrates the fact that neurofibromatosis is sometimes inherited and sometimes met with as a family disease, and gives support to the view that the chief etiological factor in the disease is one which dates from intra-uterine life. Other defects of developmental origin are frequently seen associated with this disease. So far as our present knowledge goes, Bruns, Goldmann, Thomson, and others consider that the condition is a form of giantism or elephantiasis of the connective-tissue elements of the peripheral nervous system.

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## DUODENECTOMY.

BY CHARLES A. PANNETT, LONDON.

THE history of the treatment of chronic gastric ulcers has passed through several stages in its evolution. The greatest advance was made when it came to be recognized that certain penetrating callous ulcers cannot be induced to heal by any known non-operative measures. Surgical intervention was thus proved to be necessary, and various suggestions were put forward as to what the appropriate treatment should be. Accumulative experience gained in clinics the world over has established the pre-eminent position that direct methods must hold over indirect procedures, of which the most commonly practised is gastrojejunostomy. The problem of the treatment of chronic duodenal ulcers is passing through the same phases of study. A very high percentage of successes after gastrojejunostomy has been obtained by Moynihan<sup>1</sup>; but abroad, particularly, a certain dissatisfaction with the results of simple gastrojejunostomy was being felt and expressed in the period immediately preceding the Great War. The essential sameness of the pathology of chronic gastric and duodenal ulcers suggests like remedies, and renders it desirable that the possibilities and results of direct measures should be explored in the case of the duodenum, as in the stomach. In this country very little work has been done in this direction, owing to the good results which have been obtained by gastrojejunostomy; but the results in foreign clinics do not approach them in the degree of success obtained. Thus Bier claims only 66 per cent of cures with simple gastrojejunostomy, but 83 per cent if it is combined with some stenosing operation upon the pylorus. Von Haberer puts his successes after simple gastrojejunostomy as low as 37 per cent, though it must be remembered that he reserves this operation for those cases where excision is impracticable. A number of observers have reported cases where gastrojejunostomy failed to bring about healing in duodenal ulcers, as proved by subsequent operation or autopsy. Haberer saw severe hæmorrhage eight years after gastrojejunostomy combined with pyloric exclusion, whilst O. Maier<sup>2</sup> reports a similar case, where two years later not only were the two original ulcers of the duodenum unhealed, but a new ulcer at the anastomotic margin had appeared.

Examples of failure to cure the symptoms of pain and hæmorrhage after simple gastrojejunostomy for duodenal ulcer could be added to from personal experience, but it must be borne in mind that it will always be possible to collect failures from any method of treatment which falls short of absolute perfection. The crux of the question is obviously the extent to which such failures occur. If our indirect methods are to be displaced by direct ones, it must be proved that the latter give a higher percentage of permanent cures than are reported by the authoritative operators in this country. Opinion seems to have crystallized abroad that radical measures, when they are practicable, are the methods of choice. The aim of this communication is



not to extol the excision of duodenal ulcers as being the best treatment at our disposal, but to popularize the operation of duodenectomy, so that the data may be collected on which we may confidently base our judgement in favour of one or other method.

The history of the operation goes back only a few years. At the German Surgical Congress held at Berlin in 1913, Richter<sup>3</sup> stood alone in recommending excision for duodenal ulcers. The operation had been followed by a very high mortality in most surgeons' hands, so that the radical removal of duodenal ulcers which had penetrated into the pancreas was held to be almost always impossible on anatomical grounds. Von Hofmeister,<sup>4</sup> who was able to report three successful duodenectomies, had injured the common bile and pancreatic ducts in one case, the patient recovering only after a protracted illness and several subsequent operations. He comments upon the difficulty and danger of the method. About 1916, however, attention was again directed to the question, and P. Clairmont<sup>5</sup> gave the first description of a technique for duodenectomy. Finsterer, and particularly Haberer, explored the possibilities of the procedure, and though both Clairmont and Haberer were cautious in their advocacy of the operation and insisted on the careful selection of cases necessary, yet gradually the field of possibility was enlarged, so that, by 1921, E. Nowak<sup>6</sup> was able to report 44 resections, the last 41 of which formed a consecutive series. This means that excision is possible in nearly every case. The degree to which the operation has been exploited abroad is to be gathered from the following statistics: H. Finsterer<sup>7</sup> reports 236 resections with a 3.4 per cent mortality (2 per cent in the last 198 cases), and H. von Haberer<sup>8</sup> 169 resections. Both these authors insist upon the good results obtained, Haberer affirming that they are beyond comparison with those following gastrojejunostomy alone or combined with pyloric exclusion. The few examples cited here are ludicrously small in comparison, and to draw any sweeping deductions from them would be absurd. Yet they illustrate the difficulties of the operation to which all authors refer, whilst the account of the technique employed may prove of assistance to other surgeons interested in this subject.

Two pathological facts assume great prominence when duodenectomy is under consideration. They are the tendency to widespread fibrosis in the neighbourhood of the ulcer, and the frequency with which two ulcers are present. This last occurred five times in my small series.\* The first phenomenon is so important because of the nearness of the common bile and pancreatic ducts and their liability to injury unless great care be taken, for they early become surrounded by fibrous tissue which has invaded the gastrohepatic ligament and pancreas. *Fig. 199* shows the anatomy of the structures in the neighbourhood of the duodenum. In the case of the stomach it is easy to control the blood-supply before resecting, by ligature of the main vascular trunks. But this is not possible in the case of the duodenum, because the pancreaticoduodenal artery conveys blood, not only to the duodenum itself, but to the head of the pancreas. It is therefore necessary to ligate the

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\* Subsequent experience has shown that the incidence of two ulcers is really greater than here suggested, and that sometimes the posterior ulcer remains unsuspected even after an examination, and is revealed only during the course of the resection operation.

numerous small branches which come off from the vessel and enter the pancreatic wall of the duodenum. This is a tedious and time-consuming procedure, but it must be done with meticulous care, since the obscuration of the area of operation by blood may lead to serious consequences from loss of the power of orientation. There are indeed two main guiding principles in duodenal resection: to keep the dissection close to the wall of the viscus, so that damage to the bile or pancreatic ducts may be avoided; to control the blood-supply by tying the small terminal branches separately.

It is necessary to gain free access to the site of operation. This can be done by a right paramedian rectus-sheath incision with retraction of the muscle. I have not yet found it necessary to supplement this by a cross-section of the rectus as recommended by Haberer and by Nowak. When the abdomen is opened, an impression of impracticability of resection is often first obtained, because periduodenitis is apt to hide the duodenum from view,

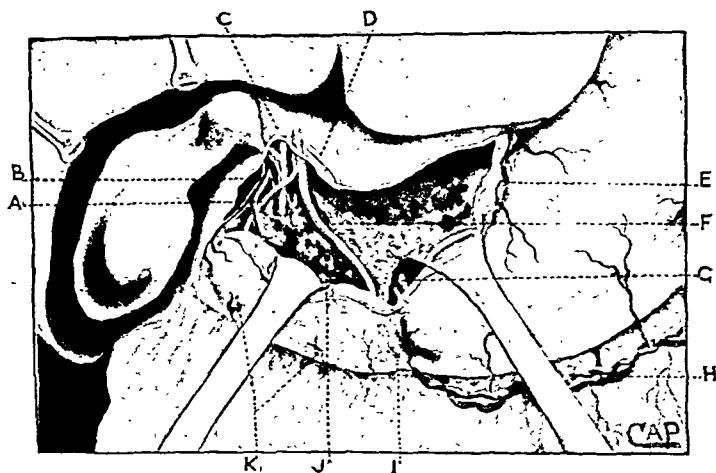


FIG. 190.—The lesser omentum has been divided: the first part and genu of the duodenum have been dissected away from the posterior wall of the abdomen, revealing the relations of it to the pancreas, bile-ducts, and neighbouring vessels. A. Pancreatico-duodenal artery; B. Pancreatico-duodenal vein, joining portal vein; C. Common bile-duct; D. Pyloric artery; E. Coronary vessels; F. Right gastro-epiploic artery; G. Superior mesenteric vein; H. Right gastro-epiploic vessels; I. Pylorus; J. Pancreas; K. First and second parts of duodenum, retracted downwards.

or to shorten it and drag it back to the posterior abdominal wall, to a pronounced degree. Clairmont pointed out how division of these adhesions frees the duodenum in a remarkable way. A surprising elongation of the viscus occurs. When this has been done, it must be decided whether it is possible to proceed without serious risk to the patient. As experience increases, so does the range of operability. I have met with two cases since I have begun resecting duodenal ulcers where I preferred to do a gastro-jejunosomy, because very extensive fibrosis obscured anatomical relations too much; but, as mentioned above, Nowak was able to perform an uninterrupted series of 41 resections. Nevertheless there are contra-indications. If the operator feels that he cannot keep clear of the common bile-duct, if he cannot define it in the gastrohepatic omentum, or if the ulcer extends so far

down that it seems probable that the common-duct papilla has been reached, then he must abandon resection. Nowak affirms that he has never met a duodenal ulcer which reached the biliary papilla; but Finsterer, with his huge experience, recognizes that some cases are not suitable for radical measures. This is only to be expected, for, in the case of the analogous gastric lesion, examples are certainly met now and then when the only possible method of treatment is the indirect one of jejunostomy, as Moynihan has pointed out. If the bile-duct in the margin of the gastrohepatic omentum can be defined, and if the finger and thumb can, by encircling the second part of the duodenum, feel only normal tissue in their grip below the callous mass in the pancreas, and it is reasonably certain that this point is above the opening of the common bile and pancreatic ducts, then the operation can be proceeded with. I think it can be accepted as true that very few ulcers reach down as far as the opening of the ducts in the second part of the duodenum.

### THE TECHNIQUE OF RESECTION.

The first step then is to cut through the attachment of the greater omentum just below the pylorus, ligating any vessels in the way. It is usually quite easy to make this separation between the stomach and the right gastro-epiploic vessels, which are then not interfered with. Quite often,

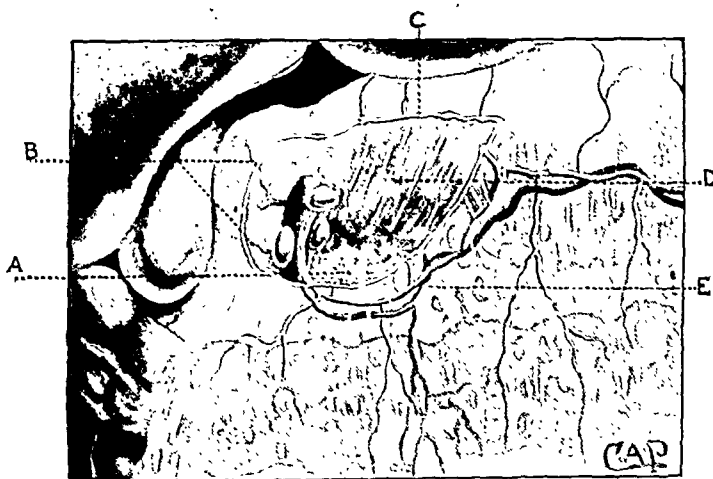


FIG. 200.—The attachment of the peritoneum to the greater curvature of the stomach and duodenum has been divided, opening up a considerable extraperitoneal space present when the lesser sac does not extend as far to the right as usual. A, Pancreas; B, Branches of pancreaticoduodenal artery; C, Attachment of the great omentum; D, Reflection of peritoneum which forms the right extremity of the lesser sac; E, Right gastro-epiploic vessels.

after this procedure, the lesser sac is not opened as is expected. It is puzzling to find another avascular layer of peritoneum spread out between the stomach and posterior abdominal wall (see Fig. 200). This is really the layer forming the right extremity of the lesser sac, perhaps drawn somewhat further to the left by traction on the stomach. If this is penetrated, the lesser sac is entered, and it is then quite simple to make a hole in the lesser omentum just proximal to the pylorus, and pass a strand of gauze round the pyloric segment of the stomach to act as a tractor, as in Fig. 201. The freeing of the border of the duodenum which is a continuation of the greater curvature of the stomach is now carried out, every small vessel being ligated before

division. If a director can be passed between the pancreas and duodenal wall below the ulcer, as depicted in *Fig. 201*, it is an immense help in subsequent steps. A ribbon of gauze should replace the director. Separation in the natural plane between the duodenum and pancreas takes place easily where there is no fibrosis. Attention is now directed to the border which is a continuation of the lesser curvature of the stomach. Here the pyloric artery should be defined, and divided between ligatures, and the attachment of the gastrohepatic ligament severed from the stomach. This separation is often one of the most difficult parts of the operation, as the ligament is apt

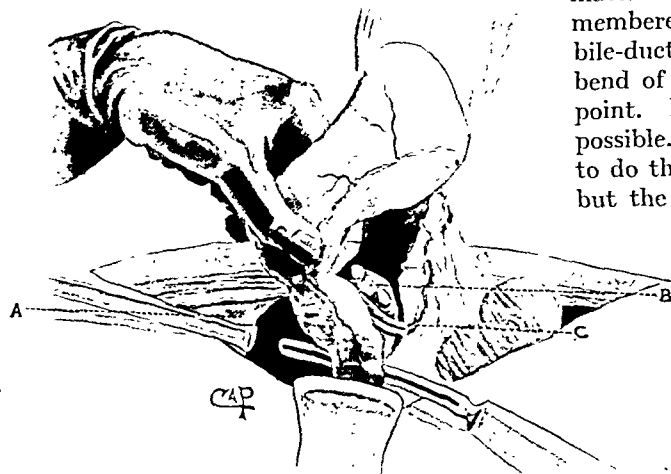


FIG. 201.—The omentum has been separated along its greater and lesser curvatures. A director has been passed between the pancreas and the duodenum distal to the ulcer. A, Liver; B, Pancreas; C, Right gastro-epiploic vessels.

to be transformed into a callous mass. It must always be remembered that the common bile-duct is very close to the bend of the duodenum at this point. It should be defined if possible. I have not been able to do this clearly in every case, but the rule to be followed is simple: Keep close to the duodenal wall and avoid mass clamping or ligations. It cannot be emphasized too strongly that caution is essential at this stage. When the viscus is sufficiently freed, access to the posterior aspect of the duodenum can be better obtained by cutting

across the stomach just proximal to the pylorus between clamps. The duodenum can thus be turned over to the right, exposing the pancreas behind and to its medial side (*see Fig. 202*). The tedious business of separating the viscus from the pancreas is now more easily performed. Each branch coming off from the pancreatico-duodenal vessels must separately be doubly ligated before division. A bloodless field is almost an essential. When there is much fibrosis of the head of the pancreas, and the proper plane of separation cannot be accurately determined, it is proper to cut round the margin of the ulcer, leaving the floor in the pancreatic tissue untouched. Escaping duodenal contents should be mopped up. Their dissemination is prevented by the preliminary packing round the area of operation, which is carried out as in any abdominal procedure. Having opened the lumen of the duodenum, it is sometimes difficult to find again the right plane of dissection below the fibrosed area. The search, however, is very greatly simplified if a strand of gauze has been thrown round the distal part of the duodenum as described above. When healthy gut has been reached, it is grasped in the blades of a

narrow clamp (a long narrow Kocher forceps will do) and cut across, the clamp remaining on the distal segment.

The restoration of continuity of the alimentary canal is brought about usually by axial anastomosis, sometimes by Moynihan's no-loop method of end-to-side gastrojejunostomy. A sufficient amount of stomach having been

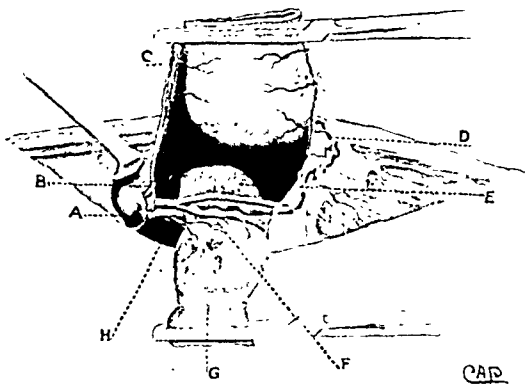


FIG. 202.—The stomach has been cut across just proximal to the pylorus. The pancreatic aspect of the duodenum is exposed, showing branches running into it from the pancreatico-duodenal vessels. Notice the proximity of the common bile-duct. A, Gall-bladder; B, C, Pyloric artery; D, Right gastro-epiploic vessels; E, Pancreas; F, Pancreatico-duodenal artery; G, Pylorus; H, Gastro-duodenal artery, common bile-duct, pancreatico-duodenal vein.

removed, the axial union is proceeded with as follows. A gastric clamp controls the escape of stomach contents. A duodenal clamp is not used for the same purpose, as it gets too much in the way, and the escape of duodenal contents is not usually too great to be dealt with. The clamp closing the duodenal end is rotated to expose the posterior aspect of the gut, and applied to the stomach as in Fig. 203.

The posterior seromuscular suture is inserted. The completion of the anastomosis follows ordinary practice. The clamp on the duodenal end is simply removed. The tissue damaged in its grasp is very narrow,

does not seem to influence healing, and is not cut away. Owing to the previous compression of the edge, there is very little hæmorrhage from the duodenal stump. Nearly always a part of the lumen of the stomach has to

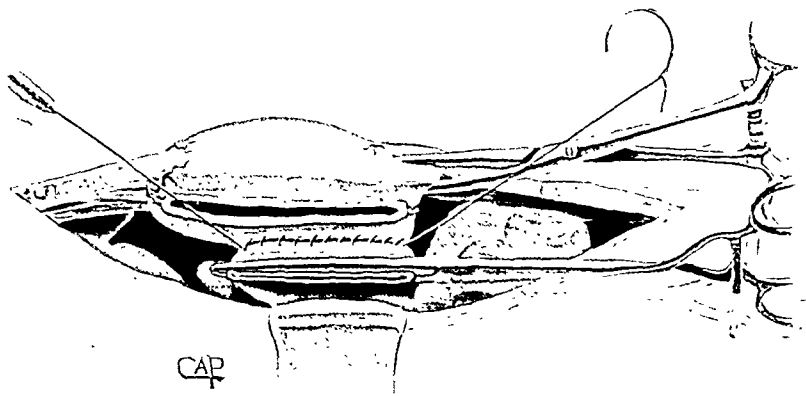


FIG. 203.—First stage in the anastomosis of the stomach to the duodenum.

be sewn up separately to adapt it to the smaller lumen of the intestine, as shown in Fig. 204. There has been no trouble at the much-feared dangerous angle. The insertion of the posterior seromuscular suture is sometimes troublesome, but it is important that the suture of the posterior wall of the

duodenum should be carefully and accurately done. Union occurs easily and firmly, as the non-peritoneal surface of the duodenum adheres quickly to the peritoneal-covered gastric surface. In *Case 2*, when the ulcer area had been separated and removed, so little duodenum above the papilla remained for suture that only one layer behind was possible. The convalescence was as smooth and uninterrupted by incident as in any other case. It is quite possible that a single Connell's suture, at least for the posterior aspect, will prove the method of choice.\*

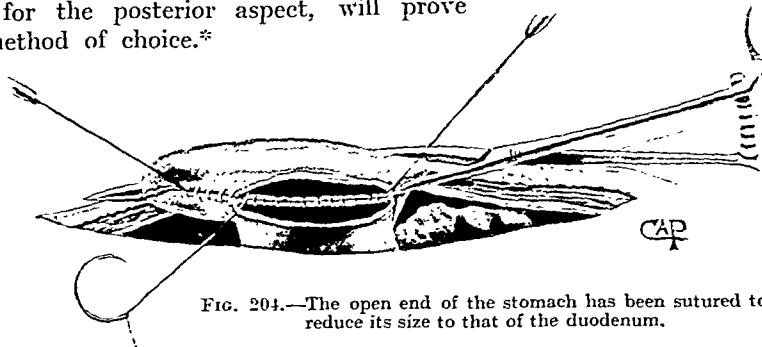


FIG. 204.—The open end of the stomach has been sutured to reduce its size to that of the duodenum.

### THE DISADVANTAGES AND DANGERS OF THE OPERATION.

One disadvantage is the length and tediousness of the operation. I have not been able to perform a partial duodenectomy under an hour and a half, and the difficult cases have taken two hours. A simple pylorectomy may be quickly done; but when any considerable length of duodenum is removed, the necessary ligation of so many small vessels consumes much time, whilst when there is a great deal of fibrosis in the neighbourhood every step must be carried out with caution and deliberation. The duration of the operation has had very little noticeable effect upon the patients. The whole procedure is performed with a minimum exposure of the viscera. Usually the small intestine is not seen, and scarcely a glimpse is had of the transverse colon. These viscera remain throughout undisturbed within the abdomen. The anaesthesia during most of the time need be only very light. The statistics quoted above demonstrate how low the immediate mortality may be. Still the operation calls for an unusually sustained effort of concentration and care on the part of the surgeon, and this may be accounted a drawback.

The dangers of the operation are not small. The major one is that of injury to the bile or pancreatic ducts. Injury of the pancreatic ducts is more serious than that of the bile-duct. This subject has been studied by P. Clairmont.<sup>9</sup> He points out that of 7 deaths following duodenectomy, 5 were due to injury of the pancreatic duct, whilst another was due to injury of the common bile-duct. Pancreatic injuries are very fatal; but sometimes recovery occurs after a stormy convalescence and, usually, secondary interventions. The injury is followed by a rapid pulse, high temperature, signs of local peritonitis, abscess formation, fat necrosis, and the appearance of a

\*This method has been employed twice since the above was written, with satisfactory results.

pancreatic fistula should the patient survive the first few days. In cases that recover are seen a striking pallor, arrest of convalescence, anorexia, great wasting, and tachycardia. Special tests show pancreatic insufficiency. In one of my patients (*Case 5*) the common duct was cut right across as it lay in the callous mass forming the head of the pancreas. As a papilla was seen in the resected portion of duodenum, it is supposed that the pancreatic duct was severed at the same time, though it was not demonstrable in the area of operation. The common bile-duct is very evident in an accident of this kind, because it gives vent to green bile; but the pancreatic fluid is colourless, whilst the duct is smaller in calibre than that which conveys bile. In this particular case, by turning in the margin of the duodenum and suturing it to the pancreas, the raw surface of this latter viscus, which had been injured and which contained the ducts, was implanted into the open end of the duodenum. A fortunately happy result followed this procedure, the patient getting quite well with comparatively little disturbance of his convalescence.

In connection with this subject certain anatomical facts must be remembered. There is very frequently an accessory pancreatic duct (duct of Santorini) which enters the duodenum nearer to the pylorus than the main duct. In 8 per cent of cases, according to Clairmont, this is of such a size that it forms the main channel for the delivery of the pancreatic juice. Normally the duct of Santorini opens about 4 cm. from the pylorus, whilst the papilla of Vater is approximately 6 cm. from the same point. Often the two openings are much closer together. In 100 cases of duodenal resection reported by the same observer, a pancreatic duct was met with fifteen times. Only by very careful dissection can injury be avoided. If a duct is not larger in calibre than that of a steel knitting-needle, it can usually be ligated and divided, as it is the accessory duct: if larger than this, it must be preserved. Injury of the pancreatic tissue alone, without division of its ducts, may cause complications. Such damage can be prevented by always leaving the floor of the ulcer on the pancreas intact, making no attempt to remove it, and, by careful hæmostasis, avoiding the necessity for passing a number of sutures through the pancreatic substance to control hæmorrhage. Ligation of the pancreaticoduodenal artery at a single point can be done apparently without any harm resulting. In one of my cases I had to ligate the trunk of the corresponding vein. There were no ill effects.

### THE PLACE THAT DUODENECTOMY SHOULD ASSUME IN THE TREATMENT OF DUODENAL ULCER.

Should resection of the duodenum displace gastrojejunostomy as the method of choice? The answer to this will depend partly upon the end-results obtained, and partly upon the as yet unproved point as to whether the increased advantage gained, should such be proved, is commensurate with the added risk of the operation. The operative mortality has been brought down to a figure not very much greater than that of simple gastrojejunostomy (v. Haberer 3.5 per cent in 169 cases, H. Finsterer 2 per cent in last 198 cases). We still await more reports of late results. Haberer regards them as very much more satisfactory than those following any indirect

method. It is essential that experience of the operation in this country should be accumulated to come to a decision on this question. Finsterer<sup>10</sup> regards resection as the method of choice. He claims, after five years or longer, 93.6 per cent absolute cures in 63 cases when the duodenum and one-half of the stomach were removed. However, he stresses the technical difficulties of it, and indeed has published a series of cases where, in preference to attempting resection, he performed exclusion of the pylorus and gastro-jejunosomy, with removal of the whole of the pyloric section of the stomach,<sup>11</sup> obtaining thereby 84.8 per cent two-year cures in 33 cases.

One other problem in connection with the operation remains to be decided, namely, the amount of stomach which it is advisable to remove at the same time as the affected duodenal segment. Some surgeons divide the stomach across, just proximal to the pylorus, whilst others, who follow the teaching of Finsterer, remove two-thirds or four-fifths of the stomach, by which means they permanently reduce the digestive power of its secretion and claim to remove the tendency to ulcer formation.

### CASES.

*Case 1.*—D. H., male, age 40. Indigestion in attacks, with free intervals, for nineteen years. Pain three to four hours after food, relieved by the next meal. Vomiting occurs. Attacks getting more frequent and longer in duration.

**BARIUM MEAL.**—Deformity persistent in first part of duodenum: some delay in emptying time.

**OPERATION.**—Aug. 28, 1923. Paramedian laparotomy with retraction of the rectus muscle. An ulcer present on upper wall of first part of duodenum, extending round to the posterior wall. A good deal of fibrosis present, extending into pancreas. Greater curvature of stomach dragged over and adherent to second part of duodenum. Preparation of duodenum and excision of the affected portion with axial anastomosis in ordinary way.

Convalescence smooth.

*Case 2.*—F. W., male, age 33. Indigestion for many years. Pain has no relation to food, but is worse if intervals between meals are longer than usual. No vomiting. Two weeks ago awoke with severe abdominal pain, which was followed by copious melaena and by fainting.

**BARIUM MEAL.**—Shows a persistent irregularity of first part of duodenum, and a residue in stomach five and a half hours after the meal.

**OPERATION.**—Oct. 18, 1923. Paramedian laparotomy with retraction of the rectus muscle. A puckered ulcer on anterior wall of first part of duodenum, and a large one behind in second part, penetrating the pancreas. Preparation of duodenum according to usual technique. Stomach cut across just proximal to pyloric sphincter. In separating the second part of duodenum, the lumen had to be penetrated by cutting round the margin of the ulcer on the pancreas. When normal duodenal wall was reached again, it was found that there was only sufficient to put in one row of sutures. Axial anastomosis between duodenum and stomach was therefore performed, using one layer of penetrating sutures behind and the usual two layers of sutures in front.

Convalescence proceeded without incident.

*Case 3.*—E. C., male, age 42. Twelve years' history of indigestion with remissions. Complaints much worse for last six months. Pain one to two hours after food. Vomiting occurs and relieves the pain. Exploration eight years ago in another hospital, but no lesion of stomach or duodenum found.

**BARIUM MEAL.**—Deformity of first part of duodenum. Small shadow persists here after stomach is empty.



**OPERATION.**—Oct. 31, 1923. Median laparotomy through old scar. A large mass present in posterior wall of first part of duodenum, extending down to second part. A large ulcer crater could be felt by invaginating the anterior duodenal wall with the finger. Much fibrosis of head of pancreas. Mesocolon dragged up in a fold and adherent to the mass. Much thickening of the gastrohepatic ligament. Separation of lesser and greater omenta from prepyloric region of stomach. Division of stomach  $1\frac{1}{2}$  in. proximal to pylorus. The duodenum was then separated from the fibrotic pancreas and gastrohepatic ligament, the floor of the ulcer being left attached to the pancreas, which necessitated incising into the lumen of the duodenum around the margin of the ulcer. Suture of duodenal stump. Anastomosis of open end of stomach to the first part of jejunum by Moynihan's technique.

Convalescence smooth.

**Case 4.**—H. P., male, age 36. Indigestion for eighteen months in attacks, with free intervals. Hunger pains.

**BARIUM MEAL.**—Stomach hypertonic, but there is delay in emptying time. Shadow of bulb indistinct. Pylorus more to right than usual.

**OPERATION.**—Nov. 29, 1923. Paramedian laparotomy with retraction of rectus muscle. An ulcer present on anterior wall of first part of duodenum. Mobilization of duodenum by usual technique, followed by excision of affected part together with the pylorus, and end-to-end anastomosis. This operation was performed without difficulty, as infiltration of the pancreas and gastrohepatic ligament was absent.

**Case 5.**—F. G., male, age 55. Nine years' history of pain and vomiting after food (four to five hours). The indigestion has been continuous, with no completely free intervals.

**BARIUM MEAL.**—Findings not distinctive: delay in emptying time.

**OPERATION.**—Jan. 9, 1924. Paramedian laparotomy with rectus muscle retraction. The following pathological condition was found at operation: scar on anterior wall of stomach, about 1 in. from pylorus; large penetrating ulcer of duodenum on posterior wall at junction of first and second parts, spreading into pancreas; cicatricial contraction of wall of duodenum opposite to the ulcer, giving rise to deep constriction. The duodenum was prepared in the usual way, but in an attempt to remove the duodenum without opening its lumen the common bile-duct was cut right across. It is believed that the main pancreatic duct was also severed—though it could not be identified in the sclerotic mass without further dissection—because, in the section of the duodenum removed, the papilla was seen. A tube was inserted up the common bile-duct and introduced into the open end of the duodenum. The cut surface of the pancreas containing the severed ducts was implanted into this open duodenal end. The stomach was anastomosed to the jejunum, though a certain length of loop was left, as there were adhesions between the first part of the jejunum and the under surface of the transverse mesocolon.

On the fourth day the temperature rose to  $101^{\circ}$ , and on the fifth jaundice appeared, but the temperature had fallen to normal. It never rose again. By the ninth day the jaundice had disappeared, and from this date convalescence proceeded without incident.

**Case 6.**—J. B., male, age 45. Indigestion for five years, with intervals free from trouble, but which have gradually become shorter in duration. Pain occurred usually one hour after food. Vomiting from time to time.

**BARIUM MEAL.**—Much delay in emptying time of stomach; eight-hour residue considerable. Deformity of prepyloric shadow, and a persistent fleck in region of first part of duodenum. Cap never seen properly filled.

**OPERATION.**—Jan. 10, 1924. Paramedian laparotomy with retraction of rectus muscle. Puckered ulcer on upper wall of first part of duodenum, just beyond the pylorus, with much infiltration of gastrohepatic ligament. A number of adhesions between gall-bladder and second part of duodenum. Pylorus and first part of duodenum excised according to usual technique. There was a broad adhesion between posterior aspect of pylorus and pancreas. Axial anastomosis between stomach and duodenum.

Convalescence complicated by bronchitis during first few days following operation ; otherwise satisfactory.

*Case 7.*—H. S., male, age 30. History of indigestion with intervals of complete freedom for more than two years. The pain appears regularly about four hours after food. Pain made worse by exercise. Occasional vomiting.

**BARIUM MEAL.**—Irregularity of pyloric shadow. Small four-hour residue.

**OPERATION.**—Jan. 31, 1924. Paramedian laparotomy with retraction of rectus muscle. Ulcer on anterior wall of first part of duodenum, and another on posterior wall at beginning of second part. Considerable fibrosis of pancreas in neighbourhood of posterior ulcer. Duodenum freed by usual technique to a point beyond the situation of the ulcers, where it was cut across. Stomach divided  $1\frac{1}{2}$  in. proximal to pylorus. End-to-end anastomosis of stomach to duodenum without clamps.

The bronchitis detectable before operation was lighted up, but the signs in chest had disappeared by the fifth day after operation. Convalescence otherwise uneventful.

*Case 8.*—C. L., male, age 44. Attacks of severe indigestion, with free intervals, began six and a half years ago. The pain bears no constant relation to the taking of food. Vomiting occurs during the attacks. No hæmatemesis or melæna, and appetite good.

**BARIUM MEAL.**—Stomach empties in average time. It is hypertonic. Duodenum not visualized distinctly. Ulcer of lesser curvature suggested.

**OPERATION.**—March 13, 1924. Paramedian laparotomy with retraction of rectus. When the abdomen was opened, the duodenum was found to be completely embedded in adhesions, binding to it the gall-bladder, omentum, and hepatic flexure of the colon. After separation of these adhesions, there were found to be a white sear on anterior wall of first part of duodenum ; a large ulcer on posterior wall, adherent to pancreas ; a stricture of the second part of duodenum ; and much infiltration of the gastrohepatic ligament. By the usual technique the affected segment of the duodenum was excised and joined axially to the stomach.

Convalescence uneventful.

*Case 9.*—G. F., male, age 29. Four years ago had severe attack of abdominal pain with vomiting. Ever since he has had constant indigestion, with only a few weeks' relief. Pain two hours after food, followed by vomiting. No hæmatemesis.

**BARIUM MEAL.**—Duodenum never seen properly filled ; six-hour residue considerable.

**OPERATION.**—March 20, 1924. Paramedian laparotomy with retraction of rectus muscle. Small ulcer on anterior wall of first part of duodenum and large sclerosed mass on posterior wall. Two adhesions between gall-bladder and duodenum. Stones felt in gall-bladder. Duodenum prepared in usual way, and ulcer-bearing area excised. End-to-end anastomosis between duodenum and stomach, which was cut across about 2 in. from pylorus. Gall-bladder opened and three stones removed. Tube sewn into gall-bladder.

Convalescence smooth. Bile drainage lasted for eighteen days.

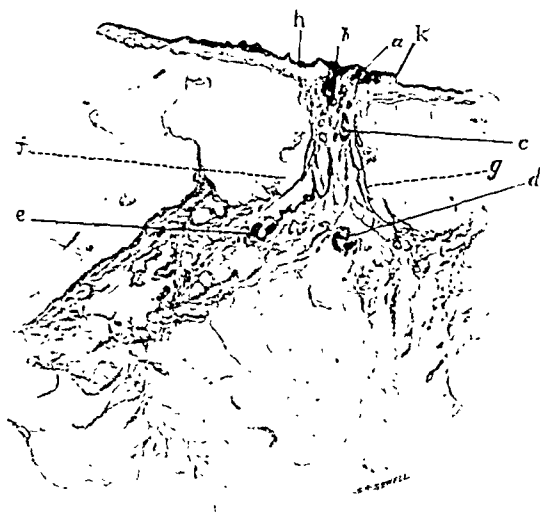
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# PAGET'S DISEASE OF THE NIPPLE.

By SIR GEORGE LENTHAL CHEATLE, LONDON.

By describing the whole sections of the breast suffering from Paget's disease of the nipple (*Fig. 205*), I add the ninth to those eight separate specimens already published in my paper entitled "Paget's Disease of the Nipple", which appeared in THE BRITISH JOURNAL OF SURGERY, Vol. XI, No. 42, 1923. It will be seen that the present example demonstrates the same problems as those I described in the previous specimens.



**FIG. 205.**—Whole section ( $\frac{1}{2}$  natural size) of breast suffering from Paget's disease of the nipple, *a*, extending between the lines *h* and *k*, in a female, age 46, married; *b* is the duct in *Fig. 211*; *c* is the duct in *Fig. 206*; *d* is a lobule in *Fig. 208*; *e* is a lobule in *Fig. 210*. The dotted lines at *f* and *g* indicate lobule sections of the same breast situated deeper in the gland than *Fig. 205*, but which have not been reproduced here; *f* refers to ducts and acini in *Fig. 209*, and *g* to a terminal duct *a* in *Fig. 207*, which leads into the lobule in *Fig. 208*. There were no enlarged axillary lymphatic glands.

There are in this specimen different varieties of primary carcinoma. For instance, in direct continuity with Paget's disease on the surface is the primary carcinoma in the duct (*Fig. 206*), which, in its structure, has no characteristics of Paget's disease of the nipple. After appearing as a primary duct carcinoma, there is an interval in which the duct is free from disease until one of its terminal branches is reached at *Fig. 207*, where carcinoma of the duct is again obvious, and the duct terminates in a lobule the epithelium of which has

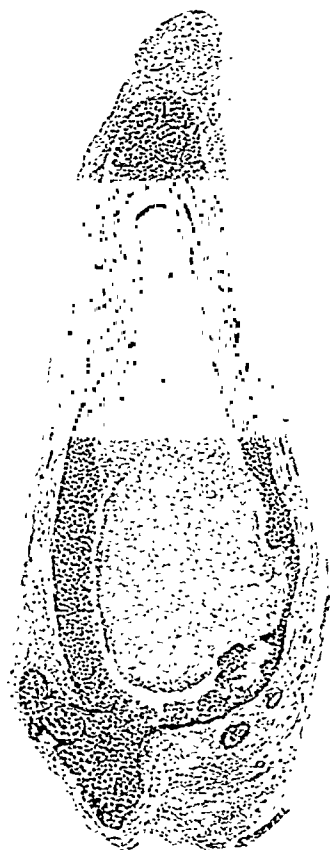


FIG. 206.—Carcinoma of duct *c* in *Fig. 205*. In other sections the epithelial cells have profoundly invaded the duct walls.

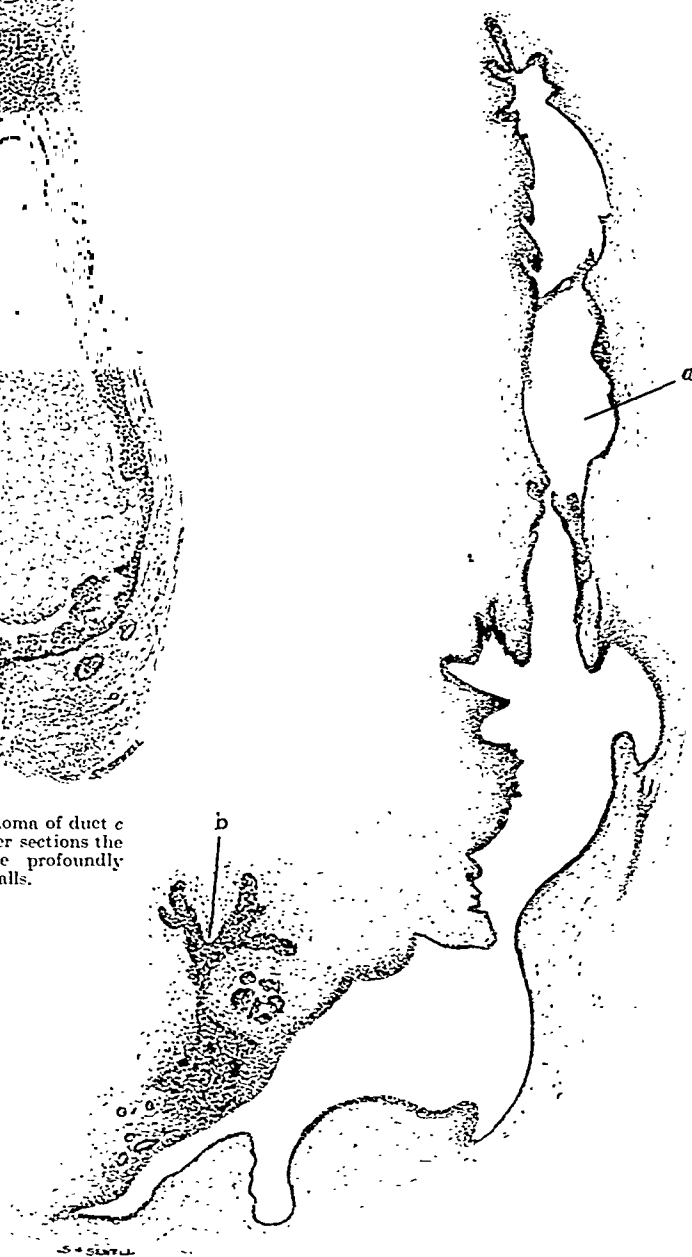


FIG. 207.—A main duct in which one of its terminals, *a*, contains duct carcinoma and leads into the lobule in *Fig. 208*. The duct is a deeper part of the duct *g* in *Fig. 205*. Carcinoma is also seen at *b*.

undergone conversion into primary acinous carcinoma (*Fig. 208*). In another duct (*Fig. 209*) is seen another primary duct carcinoma, more papillomatous in type than that in *Fig. 206*. There is acinous carcinoma in *Fig. 210*.

There is another example of similarity between this specimen and those previously published; take the duct *c* in *Fig. 205*, which is part of the duct *a* in *Fig. 207*. A long interval of the duct is free from disease, which reappears in a terminal branch of it at *b* in *Fig. 207*. The distribution



FIG. 208.—The carcinomatous lobule into which the carcinomatous duct *a* in *Fig. 207* leads, and corresponding to *d* in *Fig. 205*.

of disease in this duct is similar to that I described in this journal. Vol. XI, No. 42, *Fig. 216*, in which only the upper and terminal parts of the duct were carcinomatous.

My explanation of these facts is that the same agents that induced the primary carcinoma in the upper parts of these ducts found an easy pathway in the dilated main ducts, and were arrested in the terminal branches, where they were able to act undisturbed.



FIG. 209.—A small collection of carcinomatous terminal ducts and acini from *f* in Fig. 205. The epithelial cells in the ducts are infiltrating surrounding tissues.



FIG. 210.—A carcinomatous lobule the exact duct connection of which I was unable to trace. The lobule is seen at *c* in Fig. 205.

*Fig. 211* is a higher magnification of the upper part of a duct at *b* in *Fig. 205*. Nearly all of the epithelium lining half of the duct has undergone malignant change at *a*.

The main problem that arose in the eight specimens previously described is apparent in this ninth specimen, i.e.: Can Paget's disease of the nipple be described as a primary lesion and the changes in the breast as secondary?

Or, can these changes be described as primary and Paget's disease of the nipple secondary? Or, can Paget's disease of the nipple and changes in the breast have no connection with each other?

I have no doubt that the changes in the breast are secondary to the Paget's disease of the nipple, for many reasons. For fuller information on these points, see my article referred to above.

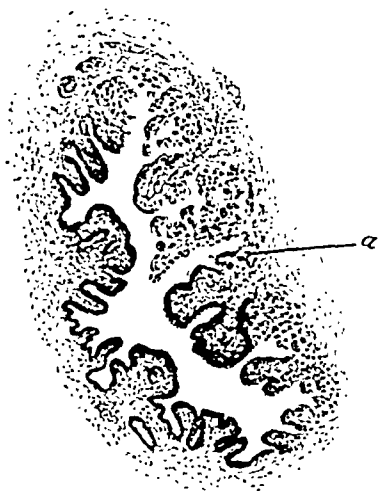
There are three more points to which I must allude:—

1. That there was no clinical sign of disease in this breast. The breast lesions could only have been detected by making microscopical sections of the whole breast.

2. In all the lesions I describe, the epithelial cells are not desquamative in type, but they are vigorous looking cells which—like carcinoma cells—are

living an independent existence and are not attached to any connective tissue base, through which other epithelial cells have spread in many parts.

3. In the connective tissue subjacent to the Paget's disease of the nipple, there are no lymphatic vessels containing carcinoma cells. The carcinoma in the breast is too early for this occurrence. Hence lymphatic vessels containing carcinoma cells can have nothing to do with the origin of the Paget's disease of the nipple.



**FIG. 211.**—The duct *b* in *Fig. 205*. Nearly all the epithelium has undergone carcinomatous change (*a*) in one half of the duct's circumference.

## THE TRANSPLANTATION OF THE FIBROUS TISSUES IN THE REPAIR OF ANATOMICAL DEFECTS.\*

BY W. E. GALLIE AND A. B. LEMESURIER, TORONTO, CANADA.

AMONG the advances which have been made in the science of surgery in the past ten years the transplantation of tissues from one part of the body to another has been one of the most important. Skin-grafting is an operation which has been studied thoroughly and which has proved of the utmost value in the treatment of wounds. The transplantation of bone has been a splendid addition to our means of promoting union in fractures, although the hopes of investigators that the transplants would continue to live intact have been doomed to disappointment. Transplanted bone dies because the bone-cells are so remotely placed in their lacunæ that it is impossible for lymph to reach them. Only those cells which lie on the surfaces of the transplant and in the open mouths of the Haversian canals and which have not yet become enclosed in lacunæ continue to live. Fortunately, the success of a bone-graft does not depend altogether on the survival of the cells, and despite the fact that most of the graft dies, it still serves as a valuable assistant in bringing about union in fractures. In the case of the fibrous tissues, however, there is no such peculiar arrangement of the cells within impermeable walls. They lie irregularly scattered among the fibres and are so accessible that even after transplantation of the tissue they are able to get sufficient nourishment from the bathing lymph to survive the operation. Many investigators have reported that these tissues may be transplanted with the full expectation that they will continue to live, and to live practically unchanged.

Before embarking on the investigation which forms the basis of this paper, we conducted a series of simple experiments on animals which completely corroborated the findings of these investigators. The animals used were rabbits, and the experiments consisted of operations in which patches of fascia, tendon, and aponeurosis were excised and immediately sewn back in their original positions. The specimens were recovered at intervals ranging from a few days to many weeks.

During the first few weeks the specimens showed the ordinary phenomena of inflammation. At first the blood-vessels in the tissues surrounding the transplants were much engorged and the whole area was covered with plastic exudate. Very soon a thin transparent film developed over the transplant, consisting of capillary blood-vessels and fibroblasts. This film rapidly

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\* The Hunterian lecture delivered at the Royal College of Surgeons of England on April 30, 1924, by W. E. Gallie, was based on the material contained in this paper. The experimental investigations involved were conducted in the research laboratories of the University of Toronto.



increased in thickness, and, by the end of the third week, had developed into a mass of spindle-shaped cells and fibres. The blood-vessels in this film

increased in size at a corresponding rate until they could be seen with the naked eye, running across the line of suture. During this time the transplant remained alive, and showed, on microscopic examination, very little change beyond a moderate œdema. Its outline remained distinct, without any evidence of invasion by new blood-vessels or connective tissue and without any leucocytic infiltration. The fibres and cells continued to stain well. (Figs. 212, 213.)

After the third week the inflammatory phenomena gradually subsided. The hyperæmia and œdema slowly disappeared, and the film on the surface became as thin and transparent as the layer of areolar tissue on the surface of normal fascia. In specimens re-

FIG. 212.—Normal fascia and aponeurosis from rabbit's back, showing arrangement of fibres and cells. (High power.) *a*, Vascular areolar tissue on surface; *b*, Deep fascia of back; *c*, Aponeurosis; *d*, Muscle.

covered as late as a year after the operation there was nothing to indicate that the cells or fibres had been changed in any way or that their physiological value had been influenced by the transplantation (Fig. 214).

These experiments were repeated many times, and always gave the same results, with the exception that when thick pieces of tendon were transplanted necrosis sometimes occurred in the deeper portions. This can be prevented by making a number of longitudinal incisions in the transplant through which the lymph may reach the cells in the interior.

Thoroughly convinced that the fibrous tissues are suitable for transplantation and that they can be expected to remain unchanged for long periods of time, we turned our attention to a study of the purposes for which they may be transplanted, and of the manner in which the operations must be performed to ensure the

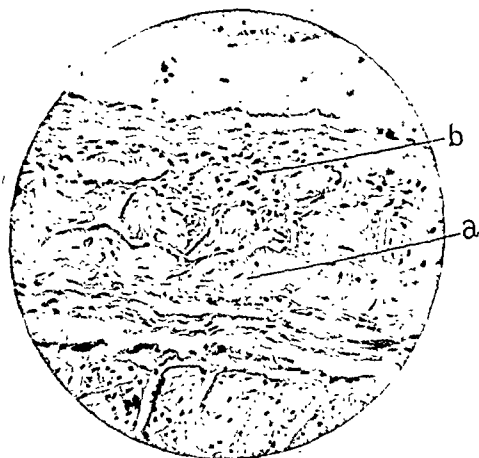


FIG. 213.—Fascial transplant recovered after three weeks. (High power.) *a*, Fascial transplant; *b*, Thick film of very vascular new areolar tissue on surface.

desired results. From time to time reports of successful transplantations of fascia lata for the repair of anatomical defects have appeared in the medical literature, but as far as we know there have been no investigations of how these successes were accomplished, and no statement of the rules which must be adopted to avoid the possibility of failure. That failures occur is unfortunately true, and they have been so frequent that the transplantation of fascia has never come into very general use. In the treatment of large ventral hernias and of direct inguinal hernias, for example, the filling of the defects with patches of fascia lata has been often described; and yet one rarely hears, nowadays, of the operation being performed.

The failures have been attributed usually to the supposed necrosis and absorption of the grafts. This explanation may in some cases be perfectly correct, for it is easy to imagine that if the transplants are placed in such a position that a free supply of lymph is not available, as, for example, in a mass of scar-tissue, necrosis and absorption might occur. The perfect regularity, however, with which success is attained in experiments on animals, and the practically complete absence of failures which has attended our own clinical work, have led us to believe that necrosis of the transplant is not the real explanation of failure.

Some years ago, in a study of the fixation of tendons to periosteum and bone, we were struck with the amount of precaution which must be taken to secure an adhesion of one structure to the other sufficiently strong to withstand ordinary physiological strain. We found that in attempting to prevent the deformities of infantile paralysis in the feet by fixing the tendons of the paralysed muscles to the bone, it was necessary to bury the thoroughly scarified tendon in a groove or tunnel for a considerable distance before solid union could be assured. Further, the surfaces of the tendon must be held firmly in contact with the walls of the tunnel for six or eight weeks. If any of the details of the operation were neglected, such as the complete removal of the areolar coverings of the tendon, and the scarification of its surface, failure of the fixation was the invariable result. Histological examination of specimens recovered at a later date clearly showed that the fixation of the tendon to the bone depended solely on scar-tissue, and that unless this scar-tissue were continuous with the connective tissue in the interior of the tendon, through wounds produced in its surface, and unless the section of tendon buried in the bone were from one to three inches in length, depending on the strain to

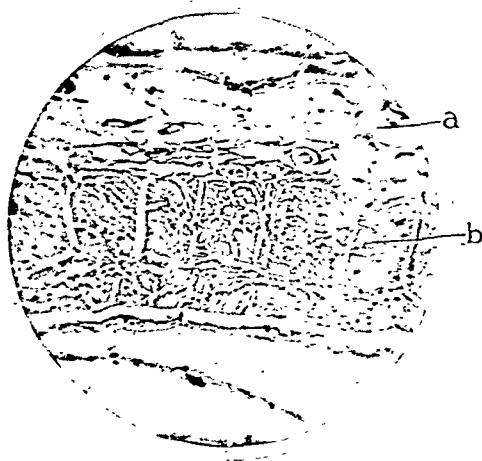


FIG. 214.—Fascial transplant recovered after thirteen months. (High power.) *a*, Areolar tissue on surface with normal blood-supply; *b*, Fascial transplant.

which the tendon would be subjected, the scar-tissue always gave way or stretched, and the deformity recurred. These observations caused us to suspect that the failures following the transplantation of tendon and fascia might be accounted for in a similar way, and ultimately led to a series of experiments on animals which have amply confirmed the suspicion.

The first series of experiments was concerned with the simple healing in the fibrous tissues. Incisions were made longitudinally and transversely in tendon, fascia, and aponeurosis, and sutured in various ways with catgut and fine silk. The specimens were recovered at intervals. When the line of incision was subjected to very little strain, as in the longitudinal splitting of a tendon or of the fascia lata, the wound healed perfectly, and in a few months could not be found either by naked-eye or microscopical examination. When the ordinary movements of the animal, however, caused a strain upon the line of incision, very different results were produced. Sometimes, as in longitudinal incisions in the middle line of the abdomen, the scar which formed was only slightly stretched. In others, as in transverse incisions through tendons and aponeuroses, the wound gave way completely and was covered only by the stretched-out areolar membranes which are normally on the surfaces of these structures. If the edges of the incision were simply drawn together into edge-to-edge apposition with an absorbable suture, the tendency to separation was greatest; but even when silk was used, although the amount of scar-tissue was increased, the stitches frequently cut out and the wound stretched open. This tendency to opening of the wound was very decidedly lessened by scraping off the areolar sheaths, and overlapping the edges. The scraping of the surfaces was of the utmost importance, as without it the simple overlapping did no good whatever. Microscopical examination showed that when the sheath was scraped away the overlapped edges healed by a scar which was intimately attached to them, whereas, when the areolar tissues were left in place, the healing simply consisted of a light adhesion of the areolar tissue on one edge of the wound to that on the other. Even when these precautions were taken, however, if the wounds were subjected to severe or long-continued strain they frequently opened up.

These observations made on animals agree fully with clinical experience. Examples of defective healing in wounds of the fibrous tissues are readily available. Thus, subcutaneous tenotomy, which at one time was very generally employed, has been demonstrated to be a dangerous operation owing to the tendency of the scar which forms between the ends of the tendon to stretch. It has been replaced, almost completely, by some other form of tendon-lengthening. The frequency of hernia through incisions in the linea semilunaris has forced the abandonment of this approach to the abdominal cavity. And the uncertainty attending attempts to close large umbilical and post-operative ventral hernias is too well known to admit of doubt in regard to the nature of the healing.

A second series of experiments was devoted to a study of the character of the healing which takes place between transplants and the tissues to which they are sewn. In one group patches of fascia were removed from the animals' backs and sewn into place again by the various methods used in everyday surgical practice. In another group segments of tendon were cut free and

similarly replaced. The specimens were recovered as before at regular intervals up to many months.

A study of the specimens obtained in these experiments confirmed completely our suspicions as to the cause of failures after transplantation of the fibrous tissues. Healing of a transplant to the tissues to which it is sewn takes place exactly as in the healing of a simple wound of the fibrous tissues. The fact that the transplant has been cut free from the circulation appears to have no influence on the character of the healing. If the line of contact is under only slight tension satisfactory union occurs, but if the scar is subjected to prolonged or severe strain the line of suture opens up and the final result is a failure. Simple edge-to-edge suture of fascia or aponeurosis and end-to-end suture of tendon give the highest percentage of failures. Careful scraping and overlapping of the edges which are in contact greatly increase the strength of the union, but even here the success of the operation depends entirely on the strain to which the line of suture is subjected. Non-absorbable sutures add to the strength of the union by increasing the amount of scar tissue and by supporting part of the strain themselves, but, as in the case of simple wounds, they frequently cut out and the same result follows as when absorbable sutures are used. (Figs. 215, 216.)

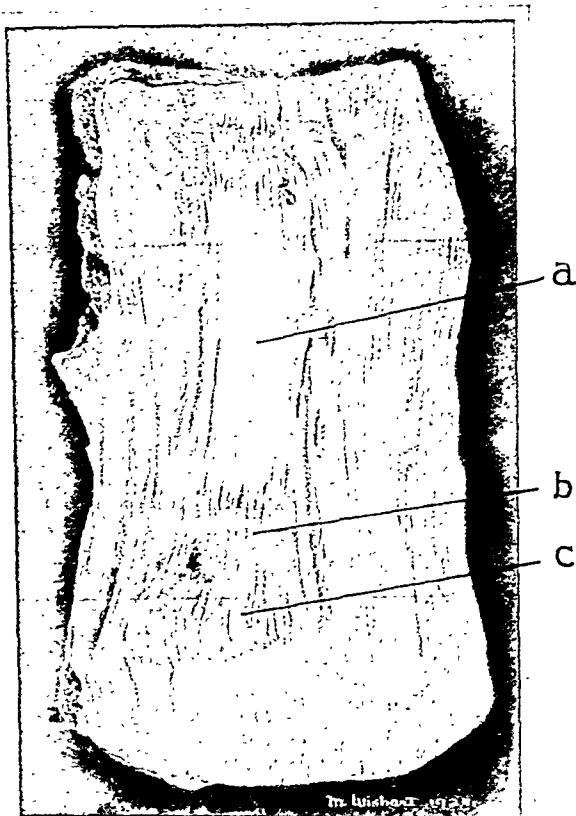


FIG. 215.—Drawing of patch-transplant of aponeurosis recovered after thirteen months. At the operation the transplant was accurately sutured all around its edge to the normal aponeurosis. Union has taken place by the formation of weak scar-tissue which has stretched considerably. *a*, Aponeurotic transplant; *b*, Thin film of new tissue uniting *a* and *c*; *c*, Edge of normal aponeurosis.

In a third series of experiments we investigated the healing of transplants of tendon and fascia to bone. The results indicated that the nature of the healing is exactly similar to that which occurs when a tendon is transferred to a new insertion. If the transplant is simply sewn to the periosteum, or placed under it, or laid in a groove in the bone for a short distance, it very soon pulls away after strain is applied, owing to the weakness of the scar-tissue which forms the bond of union. To make certain of a permanent

fixation it is necessary to scarify the surface of the transplant and to place it in close apposition with raw bone for a considerable distance, from one to three inches, depending on the anticipated strain. If it is intended to bury the tendon in a groove, the most certain method of fixation is to split it into several tails and to pack it into the groove along with slivers of the bone removed with the gouge. The periosteum is sewn over all. In this way the surfaces to which adhesions will take place are greatly increased and the scar-tissue is carried into the depths of the transplant. The most generally useful method of fixation, however, is to pass the end of the transplant, which has been split into tails, through a drill-hole in the bone, and to fix it there by some form of absorbable suture which will hold it in place till healing occurs.

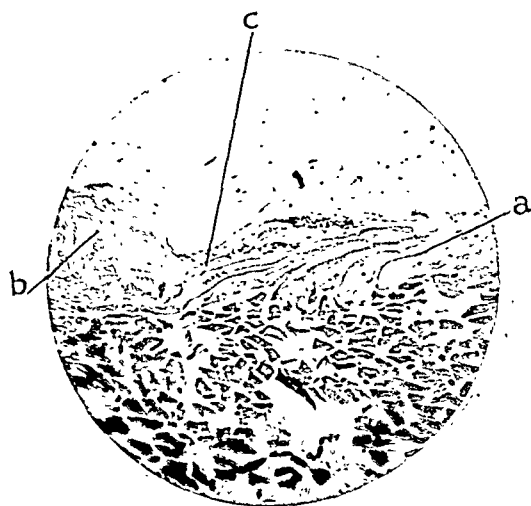


FIG. 216.—Line of union between aponeurotic transplant and normal aponeurosis after thirteen months. (High power.) *a*, Aponeurotic transplant; *b*, Normal aponeurosis; *c*, New scar-tissue between the two.

These simple experiments have been useful in fixing our attention on the weak point of the usual methods of filling anatomical defects with transplants of the fibrous tissues. Evidently edge-to-edge suture of aponeurosis or fascia should only be done where the tissues can be brought together without tension, and where the subsequent physiological strain will be slight. It will be rare indeed to find an occasion in which this method will be useful in sewing in a transplant. The experiments indicate that, in practically all cases where transplants are required, it is necessary to overlap the edges freely and to scrape and scarify the surfaces which are placed in apposition, before firm healing can be expected.

Silk or linen would appear to be the suture material of choice.

The objections to these refinements of technique are considerable. In the first place, many surgeons, in common with ourselves, hesitate to use non-absorbable sutures owing to the frequency with which they set up late irritation. In the second place, the operation is made long and difficult, and the additional handling of the tissues adds to the chances of infection of the wound. And, lastly, the precautions by no means eliminate the possibility of separation of the wound, as, after all, the union is dependent on scar.

In thinking over various means of getting rid of these objections, it occurred to us that it might be possible to eliminate the patch-transplant altogether, and replace it by living sutures made from fascia lata. To test this idea, a series of experiments was performed in which strips of fascia a quarter of an inch wide and about six inches long were removed from the rabbits' backs, and, after being threaded on a needle, were used to sew together

the edges of the gap left by their removal. The edges were not drawn into apposition but were left apart, so that the whole strain would come on the suture and not on any scar-tissue which might form in the line of union. To test the effect of the operation on the strength of the sutures, we made a rough estimate, by means of a special machine, of their tensile strength at the time of the operation and again when the specimen was recovered. We also studied the question of stretching or contraction of the suture by attaching to it at accurately measured intervals two black silk threads to act as markers. The distance between these markers was measured again when the specimen was examined. The specimens were recovered at intervals from a few days to two years after the operation.

The changes which occurred in the sutures agreed accurately with those already described in the case of patch-transplants. A few days after the

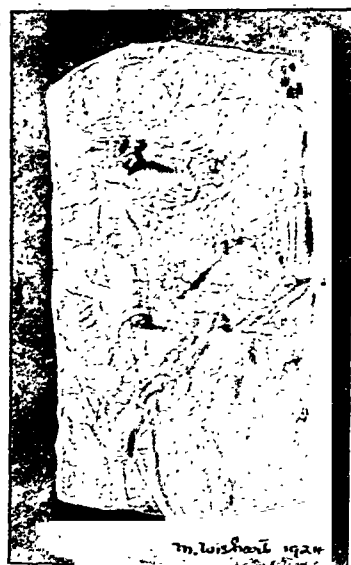


FIG. 217.—Drawing of living suture of fascia, recovered three weeks after its insertion in rabbit's back. On the upper stitch are shown the two black silk markers used to test the effect of the operation on the length of the suture. Dilated blood-vessels can be seen traversing the area in the areolar film which forms over the suture.

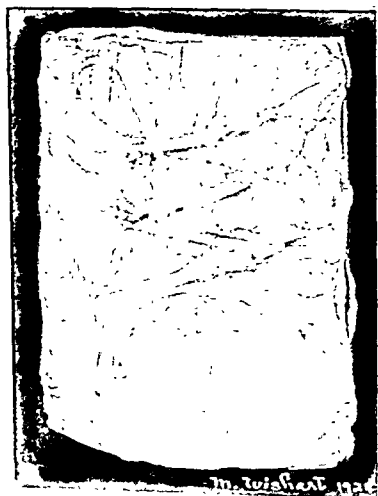


FIG. 218.—Drawing of living suture of fascia, recovered thirteen weeks after insertion in rabbit's back. The suture is now a rounded glistening cord which closely resembles tendon.

operation the surrounding tissues were hyperæmic and the whole area was covered with a thin layer of exudate. The suture was distinctly swollen. At the end of a week minute new blood-vessels could be seen spreading through the film on the surface of the suture; these increased in size until towards the end of the third week, by which time the film of exudate had been converted into ordinary areolar tissue.

As a result of following the needle through the needle-holes the suture had been folded longitudinally. It was completely surrounded by the new film of areolar tissue, which sent processes with new blood-vessels between the folds. A cross-section made at the end

of the third week shows the suture folded loosely together and completely surrounded with areolar tissue, which extends inward among the folds like the stroma of one of the glandular organs. The cells and fibres of the suture itself remained unchanged. During the succeeding weeks the inflammatory reaction subsides and the œdema disappears. The suture shrinks until it appears like a glistening white tendinous cord. In longitudinal section it looks like normal fascia, and in cross-section it closely resembles tendon.

The folds are now so closely pressed together that they can be scarcely recognized, and the processes of areolar tissue which extend among the folds have become so thinned out as to resemble the normal connective-tissue stroma of a tendon. Surrounding the whole is an areolar film from which the stroma with its blood-vessels passes into the cord. Specimens recovered after the lapse of many months appear to have undergone no further change. No stretching or contracture occurs, and the strength of the suture is approximately the same as at the time of operation (*Figs. 217-225*).

The effectiveness of strips of fascia as sutures is fully demonstrated by the specimens. It appears to be necessary only to anchor the suture securely at its two ex-

FIG. 219.—Drawing of living suture of fascia, recovered two years after insertion in rabbit's back. It does not appear to have been changed by the lapse of time.

tremities and to make sure of getting a good grip of the edges of the gap in the fascia to hold them permanently in their original position. The superiority of the suture over absorbable material is self-evident, and over linen, silk, or silver wire it has the advantage that it has no tendency to cut out or to set up irritation of any kind. Unlike these materials, it heals to the edges of the defect at the points where the needle passes through them.

The idea of using strips of the fibrous tissues as living sutures appears to have solved the uncertainty which attended the use of patch-transplants.



FIG. 220.—Cross-section of portion of fascial suture after three weeks. (Low power.) *a*, Folds of fascia; *b*, New connective tissue surrounding the whole suture and extending into the spaces between the fascial folds.

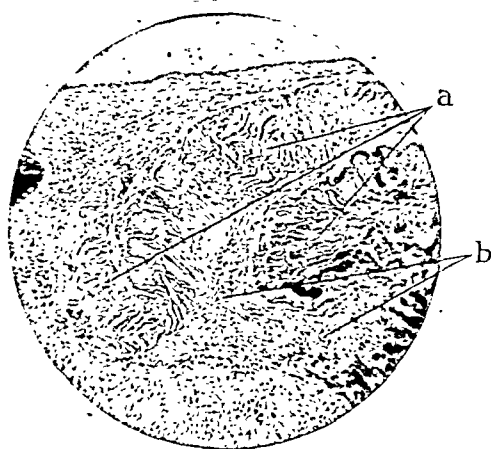
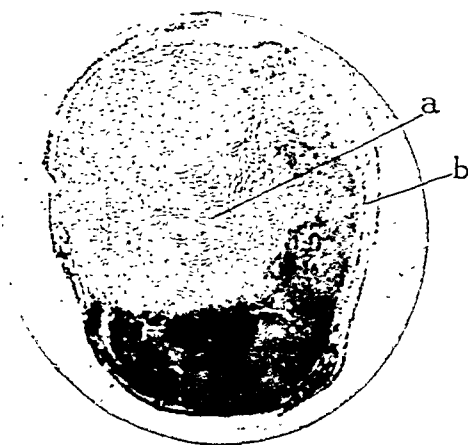


FIG. 221.—High-power photograph of same section as shown in Fig. 220. The cells of the fascia are stained well, the outline of each fold is distinct, and there is no invasion of the fascia itself by new tissue. *a*, Folds of fascia; *b*, New tissue between the folds.

FIG. 222.—Cross-section of fascial suture after six weeks. (Low power.) The suture is now a rounded cord. The separate folds can no longer be distinguished, and the new tissue between them is represented merely by narrow trabeculae of connective tissue. *a*, Rounded cord of fascial suture; *b*, Vascular areolar tissue.





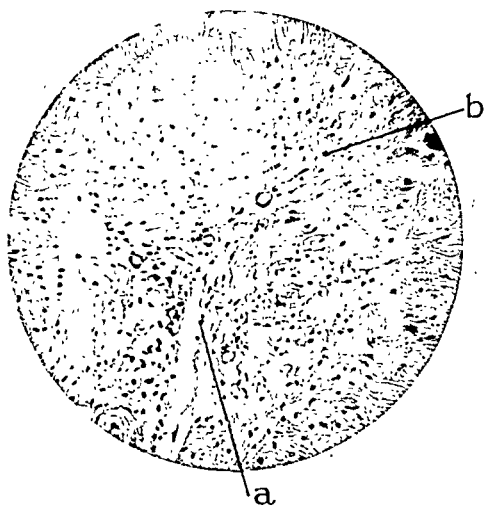


FIG. 223.—High-power photograph of same section as shown in *Fig. 222*. *a*, Connective tissue between the folds of fascia; *b*, Fascia, which is obviously alive and resembles normal fascia in every way.

FIG. 224.—Longitudinal section of fascial suture after six weeks, showing the persistence of the normal parallel arrangement of the fibres. (High power.)

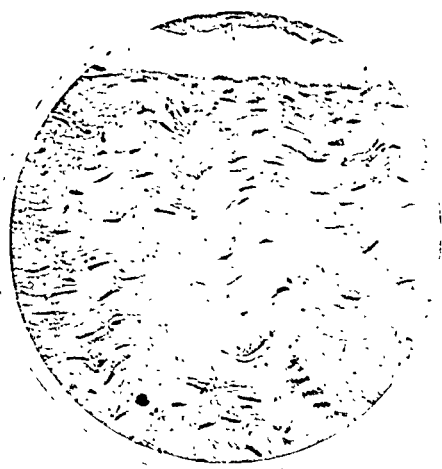


FIG. 225.—Cross-section of fascial suture after two years. (Low power.) It is still in the form of a rounded cord, and shows no appreciable change from the six-weeks' suture depicted in *Fig. 222*.



In the latter the whole success of the operation depends on the character of the healing of the transplant to the tissues to which it is sewn, whereas, in the former, this doubtful factor is completely removed and the whole test of the effectiveness of the operation falls on the transplant itself. If this lives and remains unchanged, and experimental evidence seems to demonstrate this, there is no reason why a great variety of anatomical defects should not yield to fibrous tissue transplantation.

### CLINICAL APPLICATIONS.

Since the commencement of our experiments, we have had ample opportunity, both in military and civilian practice, to test clinically the principles outlined. For purposes of description the cases may be grouped as follows: (1) *Injuries to Tendons*; (2) *Injuries to Ligaments*; (3) *Certain Ununited Fractures*; (4) *Paralytic Deformities*; (5) *Facial Paralysis*; (6) *Ptosis of Viscera*; (7) *Hernia*.

#### 1. INJURIES TO TENDONS.

Of these we have had a great variety, usually wounds of tendons which have failed to unite and in which contracture of the muscle has made it impossible to bring the ends of the tendon into apposition. The cases include several in which transverse wounds on the palmar aspect of the wrist have divided all the structures from the skin to the bone. The majority, however, have been cases of ununited wounds of one or more important tendons. How these cases shall be dealt with depends on the amount of strain the tendon is normally called upon to withstand. To fill the gap with a transplant of tendon or fascia placed in neat end-to-end apposition seems to us to be too uncertain a method to merit consideration. Failures or partial failures owing to stretching of the scar are very frequent. The strength of the union can be increased by bevelling the ends where they are in contact and thus enlarging the area of the raw surfaces which are opposed to one another. Since the idea of living sutures suggested itself, however, we have employed these on nearly all occasions. An example will illustrate the manner of their use.

A butcher was admitted to hospital with a marked disability of the hand which had resulted from a knife wound, six months previously, through the thick of the thumb. The flexor longus pollicis had been severed, and the cut ends were widely separated. The ends of the tendon were exposed by two incisions, one along the inner border of the short muscles of the thumb, and another above the wrist. They were drawn together as closely as possible, but a gap of three-quarters of an inch still persisted. A thin strip was then cut from the tendon of the palmaris longus, about four inches in length and one-sixteenth of an inch thick, and threaded on a needle. It was tied into the needle with fine silk, and a catgut ligature fastened around its terminal end to prevent fraying. Without freshening the ends of the severed tendon in any way they were woven together with the living suture, much as one splices a rope, or, better, laces a leather belt. The suture was first anchored in the end of the tendon nearest the muscle by passing the needle into the side and out of the end of the tendon and then through the tail of the suture. In

this way a firm slip-knot was made which could not cut out owing to the scar-tissue on the end of the severed tendon. The suture was then carried backward and forward across the gap, making sure to get a good grip of the ends of the tendon, until the suture was used up. It was finally anchored by splitting the tail into two strands and tying them together in a triple knot around one of the loops of the suture. The knot was secured against untying by transfixing and tying it with a catgut ligature. The patient commenced active movements of the thumb in three weeks, and returned to his work in two months. It is now four years since the operation, and he has perfect function in the thumb.

The advantages which we see in the method are several. In the first place, it is simple and easy of execution. In the second place, it allows the cut ends of the tendon to be drawn together under strong tension, and thus restores the muscle as closely as possible to its normal length; this is of importance if the normal power and range of motion are to be restored. And lastly, it eliminates the element of chance which attends healing by scar-tissue, and places the whole responsibility for union upon the transplant itself and on the manner in which it is woven into the ends of the tendon.

#### **Injuries to Tendons which normally are Subjected to great Strain.—**

*Ligamentum Patellæ.*—While the method described above has proved perfectly satisfactory in bridging gaps in ordinary tendons such as those of the forearm, we have hesitated to trust to it in wounds of such powerful tendons as the ligamentum patellæ. Of this latter condition we have had four cases; one in which the tendon had been ruptured at its middle, about a year previously, by a fall on an iron radiator; one in which the tendon had been evulsed from its insertion and failed to unite to the bone after prolonged fixation; one in which the tendon had not united firmly after suture with catgut following a transverse operative incision into the knee-joint; and one in which the tendon had been forcibly torn from the patella, carrying with it a small flake of the bone. Each of the cases came into our hands a year or more after the accident, and showed such a degree of disability through absence of power to extend the knee that operative treatment was required. In all of the patients the patella was held high above the condyles of the femur and there seemed to be little prospect of drawing it down to its normal position. We were consequently faced with the necessity of bridging a gap with a transplant and at the same time making the repair so strong that it would withstand tremendous degrees of strain. After some consideration an operation was devised which has proved satisfactory in all four cases and can be employed equally well in all types of the injury.

Through an S-shaped incision on the front of the knee-joint, the patella, the remains of the injured tendon, and the tubercle of the tibia are freely exposed. The pieces of the tendon are split longitudinally in the middle line, from the patella to the tubercle. With a  $\frac{3}{16}$ -in. drill two holes are bored through the patella from the upper to the lower border. At the upper border these drill holes are about one inch apart, and at the lower about half an inch. At the lower border, therefore, when the drill has passed through the bone, it enters the remains of the ligamentum patellæ. It is pushed steadily onward until its point appears in the median incision in the old tendon. A  $\frac{3}{8}$ -in. drill is now applied to the tubercle of the tibia, and a deep hole is bored obliquely

downward into the bone. A  $\frac{3}{16}$ -in. drill is then applied to points on the internal and external surfaces of the tibia about an inch below the hole in the tubercle, and holes are bored which incline obliquely upward to meet the large hole in the depths of the bone. At this stage the patient is turned on his side and the tendo Achillis of the same leg exposed. A segment of this tendon, composed of half its thickness and about seven inches long, is removed and

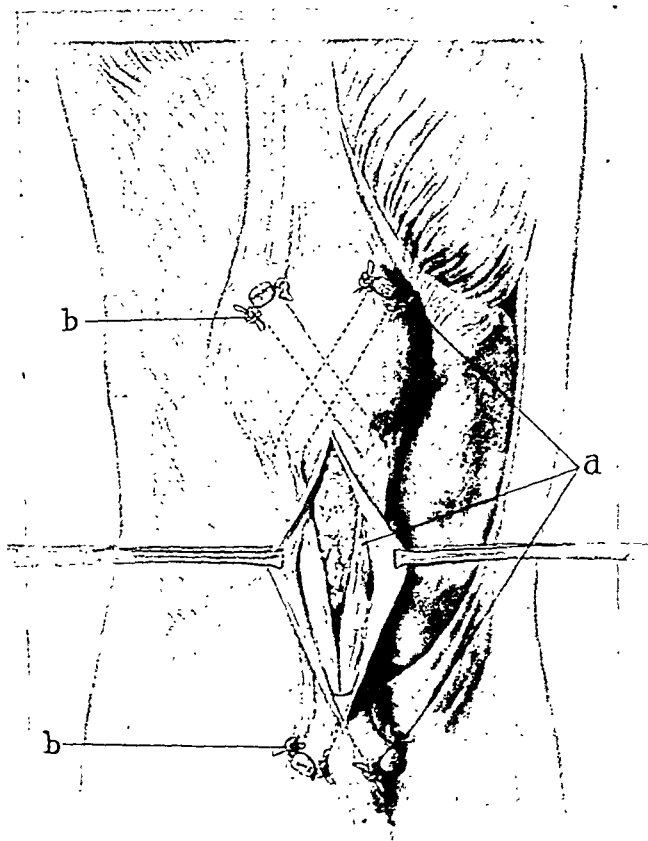


FIG. 226.—Drawing of operation for the repair of ruptured ligamentum patellæ.  
a, Segment of tendo Achillis drawn through holes in patella and tibia b, Kangaroo sutures which fasten the transplant in place until firm healing occurs.

split into two equal parts. All areolar tissue is carefully scraped away, and—from above downward—the transplants are threaded through the holes in the patella into the large hole in the tubercle of the tibia and out through the small holes in its internal and external surfaces. The patella is then dragged downward with sharp-hooked retractors as far as it can be induced to come, and the new tendons are pulled taut and sutured together and to the

neighbouring periosteum with kangaroo tendon. This suturing must be done thoroughly, as upon it depends the anchoring of the patella until the new tendons become firmly healed to the bone. As the total cross-section of the transplanted tendon is considerably less than that of a normal ligamentum patellæ, we have thought it wise to give additional strength to the repair by bridging the gap in the old tendon by a living suture made from the tendon of the plantaris longus, or, if the rupture has taken place at the attachment to the tibia or patella, by weaving the living suture into the end of the tendon and through the holes in the bone. The old and new tendons are finally sewn

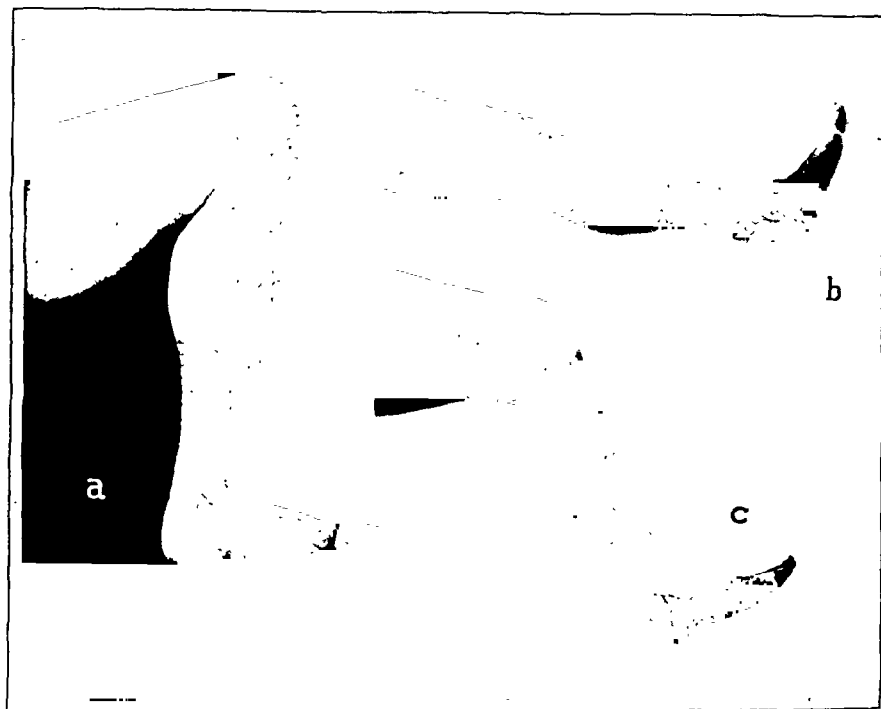


FIG. 227.—Photographs (a, b, c) of patient operated upon five years ago for rupture of the ligamentum patellæ. They show the range of voluntary movement to be normal, and give some idea of the power in the extensors.

together into a compact mass with catgut. (*Fig. 226.*) The limb is encased in plaster-of-Paris for about eight weeks, after which active movements are begun.

This operation has so far proved entirely satisfactory. All four patients are workmen who are engaged in laborious occupations. The first patient, a bricklayer, was operated on five years ago. The others were operated on four, two, and one year ago respectively. They have no disabilities whatever. (*Fig. 227.*)

*Rupture of the Quadriceps Tendon.*—There have been two cases of rupture of the quadriceps tendon at its attachment to the patella, which had at first seemed to be healed firmly, but in which the scar ultimately became stretched. These were treated by suturing the end of the tendon to the patella with several

mattress sutures of fascia lata. They were woven securely into the tendon and then passed through vertical holes in the patella. The ends were woven into each other and sutured with catgut. No preliminary dissection of the end of the quadriceps was done for fear that it might lead to cutting out of the sutures. These patients have been walking for about a year and have no disability.

*Ununited Wounds of the Tendo Achillis.*—This not very uncommon condition lends itself well to treatment with living sutures. The type of operation required will depend on the nature of the injury, but the presence of the plantaris tendon in the neighbourhood makes the problem easy. This tendon makes an ideal suture, as it is so slender that it may be used in place of catgut to sew together the freshened ends of the tendo Achillis if these can be overlapped, and it is so strong that it may be used to bridge a gap when the ends of the severed tendon cannot be brought together.

Our first patient was a young man who had received a wound in the middle of the tendo Achillis some months previously, and in whom the scar had become so stretched that he had no power to plantar-flex the foot. The operation consisted of a dissection of the ends of the tendon, with removal of the scar, so that they could be overlapped. They were then sewn solidly together with sutures made by splitting the plantaris tendon into two strands. The result was excellent.

We have at present under observation a patient who two years ago ruptured his tendo Achillis at its attachment to the os calcis. He was treated by prolonged fixation of the foot in the equinus position, but the subsequent strain of walking separated the tendon from the bone or so elongated the scar that the plantar-flexor power of the foot was lost. We propose to repair the defect by splitting the tendo Achillis as in a tendon-lengthening operation and using half of it as a free transplant. This will be passed through a hole in the os calcis and anchored there with catgut. The two halves of the tendon will then be sewn together with a 3-in. to 3½-in. overlap. If it seems advisable the plantaris tendon will be used as a living suture to reinforce the repair.

Up to the present all the cases of injuries of tendons that have been treated with transplants of tendon or fascia had been under treatment for several months before operation. We have not had occasion to treat a case at the time of the accident. We are so convinced, however, that the healing of such structures as the ligamentum patellæ and the tendon of the quadriceps is unlikely to prove sufficiently strong to stand the strain of normal activity, that, when the occasion arises, we shall attempt to repair the damage immediately by some form of fascial transplant or by living suture.

## 2. INJURIES TO LIGAMENTS.

*Habitual Dislocation of Patella.*—It is rare that injuries to ligaments require operative treatment. Yet in ligaments, as in tendons, firm healing does not always take place. As a result, dislocations are likely to recur and become exceedingly troublesome. Our attention was first drawn to the condition in 1917 when a soldier was admitted to military hospital with a lateral dislocation of the patella. His history was that a year previously the

patella had been dislocated during a collapse of a dug-out. The treatment had consisted of immobilization of the limb in full extension for several weeks. Two months later the displacement recurred during sudden bending of the knee. A plication of the inner portion of the capsule with catgut was then performed, but within four months the dislocation had recurred again. After this last recurrence it was found that the patella would slip outward over the condyle as soon as the pressure of the hand was removed from it. In view of this, further treatment was abandoned. When he came under our observation the patella was lying on the lateral aspect of the lower end of the femur and could not be dislodged from this position. The man walked only with crutches, and complained of great pain whenever the joint was moved. The cause of the recurrence of the dislocation was the marked degree of knock-knee which was present.

The following operation was performed: The patella was freed of adhesions by dissection and forcibly lifted back into the intercondylar notch. Through a vertical incision on the inner side of the joint the inner border of the patella and the internal condyle were exposed. A transverse hole was then drilled through the widest portion of the patella with a  $\frac{1}{4}$ -in. drill, and two other holes, separated by about an inch, were bored in the internal condyle so that they met in the depths of the bone. A segment of the tendo Achillis composed of half its thickness and about seven inches long was then removed and passed through the hole in the patella, into one of the holes in the condyle, and out of the other. The patella was drawn as far inward with a hooked retractor as it would come, and the new ligament was drawn taut and anchored to the patella and the condyle with kangaroo sutures. The wounds were closed and the limb encased in plaster-of-Paris, which was moulded against the outer side of the patella to prevent recurrence of the displacement if the sutures should loosen. Massage and movements were commenced in about seven weeks, and after three months the patient was discharged cured. He was examined a few months ago, six years after his operation, and reported that ever since he was discharged from hospital he has been at work without disability as a motor mechanic. During flexion and extension of the knee the new ligament can be felt and seen standing out like a whip-cord between the patella and the condyle. (*Fig. 228.*)

Habitual dislocation of the patella is much more common than we had supposed. Since the operation just described we have seen seven cases, all occurring in girls and young women, without any predisposing cause other than relaxed ligaments. It is an exceedingly annoying condition, as the displacement is liable to occur most unexpectedly, and always produces great pain and sometimes serious falls. Many operations have been designed to overcome it, but few have been completely satisfactory.

One method in particular deserves criticism, namely plication of the capsule. When one remembers the nature of the healing that occurs in wounds of the fibrous tissues, the futility of pleating an uninjured ligament, such as the capsule of a joint, with catgut sutures, must be apparent. To illustrate this point we did a few experiments in which the fascia of the back in rabbits was plicated with catgut and various other suture materials. In some the areolar covering was left undisturbed, but in others it was carefully

scraped away and the fascia scarified. Invariably the folds disappeared after a few weeks and nothing was left to indicate that any operation had been performed. Plication of the fascia with a living suture, on the other hand, is permanent, and suggests at once that if one desires to plicate the capsule of a joint, a suture of tendon or fascia lata should be employed.

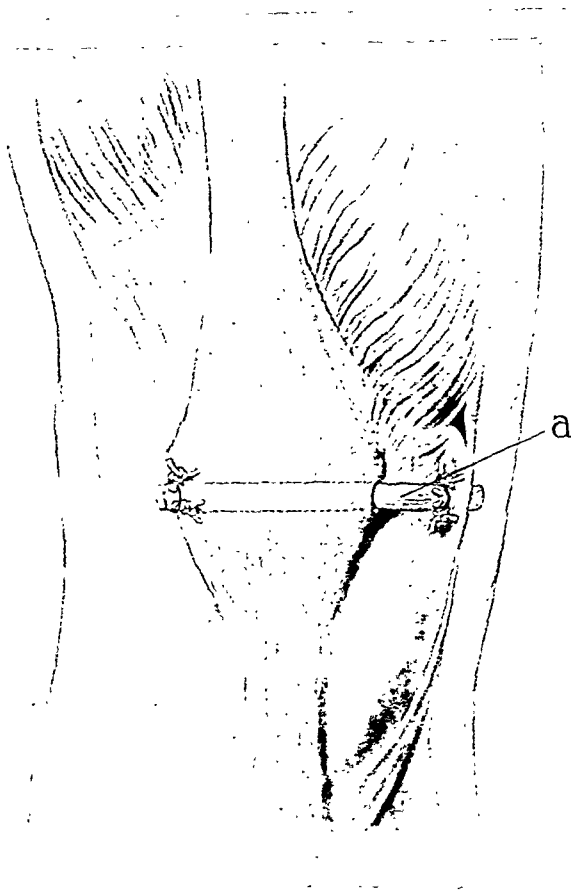


FIG. 228.—Drawing of operation for recurring lateral dislocation of the patella in which great force is required to prevent the displacement. *a*, Segment of tendo Achillis passed through holes in the patella and internal condyle and fastened in place with kangaroo sutures.

For habitual dislocation of the patella, however, we have not trusted to plication of the capsule, as it is such an easy matter to tether the patella to the condyle without disturbing the ligament. The operation resembles that performed on the soldier described above, except that fascia lata is substituted for the tendo Achillis. Through two short incisions, one on either side of the patella, two holes are drilled transversely through the bone. Through another short incision over the internal condyle two holes are drilled into the femur,



which meet in the depths of the bone. A strip of fascia lata, half to three quarters of an inch in width and ten inches long, is obtained from the lateral aspect of the thigh and firmly ligated at each extremity with strong silk. With the assistance of the silk the strip of fascia is drawn from without inward through the holes in the patella so as to form a loop along its outer border. A pair of artery clamps is then passed subcutaneously from the incision over

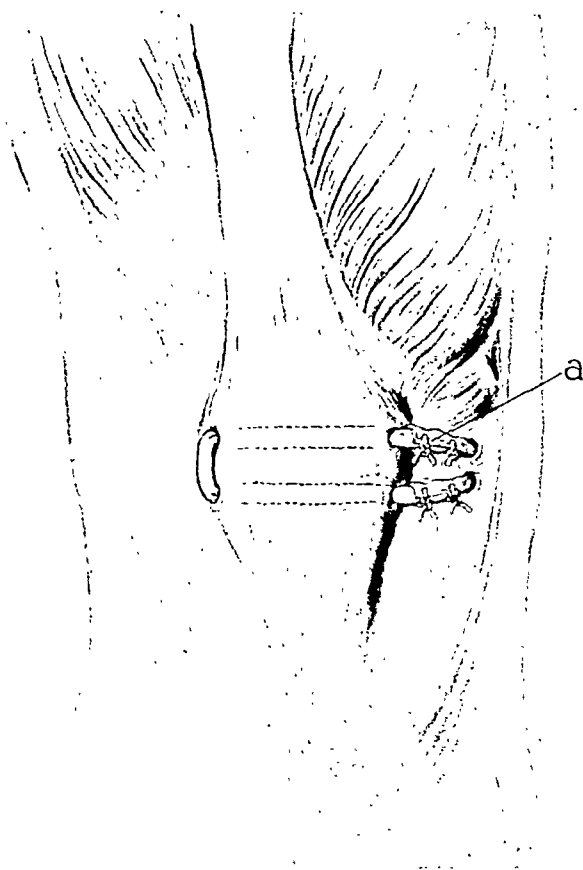


FIG. 229.—Drawing of operation for habitual dislocation of the patella. *a*, Strand of fascia lata, half an inch wide, passed through holes in the patella and internal condyle and fastened with catgut.

the condyle to the incision on the inner side of the patella, and the ends of the fascia are drawn through the subcutaneous tunnel. Again utilizing the silk, the ends of the fascia are drawn through the holes in the internal condyle and pulled sufficiently taut to hold the patella firmly inward. The overlapped portions of the fascia are then freed of areolar tissue and woven through one another once or twice and sutured together with catgut. The silk ligatures are finally removed and the wounds closed. A plaster bandage

is applied from the toes to the upper portion of the thigh with the knee in full extension. (*Fig. 229.*)

The subsequent history of these seven patients has been satisfactory. Movements of the knee were commenced after six weeks, and within a few weeks more the function of the joint was normal. In none of the cases has there been a recurrence of the dislocation.

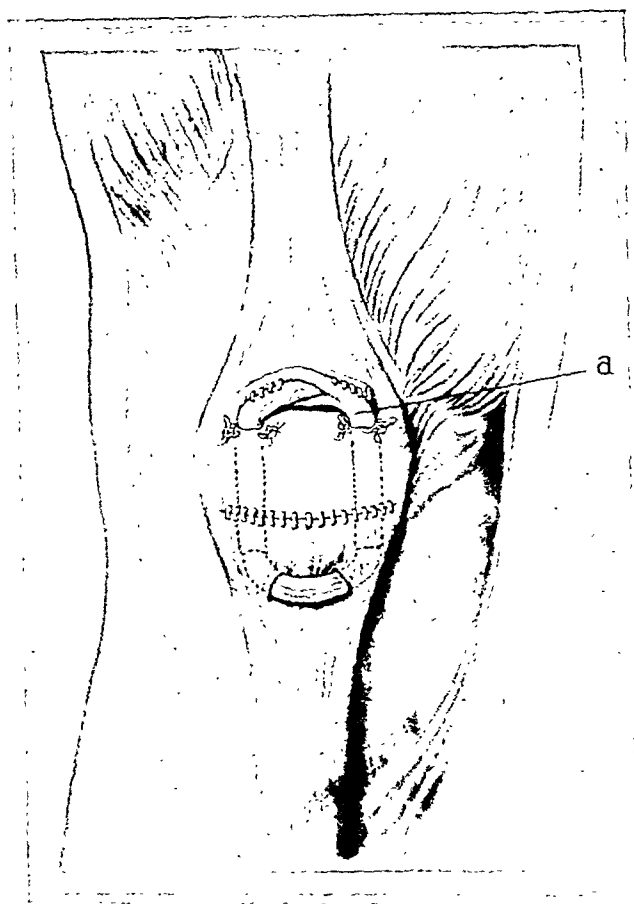


FIG. 230.—Drawing of operation for repair of ununited fracture of patella in which one of the fragments is a mere flake of bone. *a*, Heavy suture of fascia lata passed vertically through the patella and transversely through the ligamentum patellæ.

**Recurring Dislocation of the Shoulder.**—The observation that fibrous structures such as the capsules of joints may be plicated successfully, if narrow sutures of fascia lata are used, suggests at once that recurring dislocation of the shoulder might be effectively treated by this means. Unfortunately the only opportunity we have had to try the method occurred at the very commencement of our experiments with living sutures, and our operation was very imperfectly performed. Recurrence of the dislocation was prompt. We

are still of the opinion, however, that the method might be useful in cases which are definitely the result of relaxation of the capsule of the joint.

### 3. UNUNITED FRACTURE OF THE PATELLA.

The success of the operations on the ligamentum patellæ already referred to led us to apply a similar method to cases of ununited fracture of the patella in which the bones could not be brought together, or in which the fracture had occurred so close to the upper or lower border of the bone that it seemed unlikely that an operation designed solely to induce union in the fracture would provide sufficient strength to withstand the normal strain. In the former the fragments were drawn as closely together as they would come, and were held in this position by a heavy loop of fascia lata passed through drill holes. The ends of the loop were freed of areolar tissue and woven through one another and sutured with catgut. By this means the continuity of the quadriceps was established and a considerable portion of the normal extensor power restored.

In the ununited fractures close to the upper or lower border of the patella, the drill holes were made in the large fragment only, and a loop of fascia was drawn through the quadriceps tendon or the ligamentum patellæ through a transverse tunnel made with a narrow knife. The presence of the small flake of bone on the end of the tendon prevented the loop from cutting out. One case will illustrate the effectiveness of this operation. The patient was a tall young man, weighing 250 lb., who had fractured his patella some months previously through the lower tip of the bone, with wide separation of the fragments. He had been treated by placing the limb on a posterior splint, but no union had taken place. He was seriously handicapped by inability to extend the knee. The operation consisted of bringing the freshened surfaces of the fragments together and inserting a loop of fascia lata, one inch in width, through two vertical holes in the upper fragment and transversely through the ligamentum patellæ just below the lower fragment. The transverse rent in the lateral expansion of the quadriceps tendon and the capsule of the knee was closed with a living suture of fascia threaded on a needle. A complete cure resulted. (*Fig. 230.*)

### 4. INFANTILE PARALYSIS OF THE SHOULDER IN SMALL CHILDREN.

In infantile paralysis involving the shoulder girdle, but sparing the trapezius, no better operation has been devised than arthrodesis of the shoulder-joint. In small children, however, it is impossible to ankylose the joint owing to the relatively small amount of bone in the articulating surfaces. In several such children we have materially improved their condition by weaving the acromion process to the greater tuberosity of the humerus with strips of fascia lata. These strips were passed through holes in the two bones and drawn sufficiently tight to hold the humerus in moderate abduction. When firm healing had occurred the patients were able to abduct and raise the humerus by means of the trapezius. The method is limited in its application, however, as there is no great reason why these patients should not wait till the bones entering into the shoulder-joint have developed sufficiently to allow a successful arthrodesis.

## 5. FACIAL DEFORMITIES.

In the field of plastic surgery, particularly in that of the face, the principle of living sutures may prove of value. It has been used with excellent results by our *confère*, Dr. W. W. Wright, in the treatment of congenital ptosis of the eyelids. In this

operation two strands of fascia lata about one-sixteenth of an inch wide are threaded on curved needles and tied in as

already described. A needle is attached to each end of the suture.

A horn plate is placed beneath the eyelid and two small puncture wounds, as shown in *Fig. 231*, are

made through the skin at *A* and *C* with a sharp-pointed tenotome about 6 mm. above the margin of the lid.

A transverse incision *B D*, 1 cm. long, is made just above the brow.

One needle is now entered at *A* and carried upward subcutaneously to

emerge at the nasal extremity of the incision *B D*. The other needle is then

entered at *A*, passed under the skin, brought out at *C*, re-entered through the same hole, and brought out above at the temporal end of the incision *B D*.

The second suture is then inserted in a similar manner in the outer half of the lid. The ends of the sutures are now drawn tightly enough to

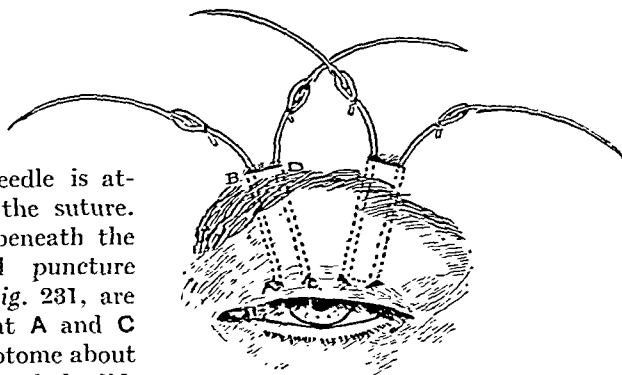


FIG. 231.—Diagram of operation for congenital ptosis of eyelid in which the lid is permanently suspended from the occipitofrontalis with narrow sutures of fascia lata.



FIG. 232.—Photographs of patient on whom the operation for congenital ptosis of the left eyelid had been performed  $3\frac{1}{2}$  years previously.

raise the lid to the desired height, and are then tied in a knot which, after transfixion with fine catgut, is dropped back into the transverse incision and buried under the skin.

The accompanying photographs illustrate the result of this operation after the lapse of  $3\frac{1}{2}$  years (*Fig. 232*). No change in the suspension of the eyelid has occurred during that time, and the boy has excellent control of it through the action of the occipito-frontalis. Twelve patients have been operated upon by this method at the Hospital for Sick Children, and all with satisfactory results.

## 6. VISCEROPTOSIS.

The uncertainty which attends operations for the fixation of viscera may possibly be removed by the substitution of strips of fascia for catgut. Our clinical experience with the method has not been great, but as far as it has gone it has been encouraging. Two cases of floating kidney which had been suffering from crises of abdominal pain were treated by sewing the kidney to the abdominal wall with sutures of fascia lata. In each case the symptoms have been relieved and the kidneys have remained in place. The first patient was operated upon three years ago, and the kidney was fixed by the simple weaving of a fascial suture through the capsule and into the lumbar aponeurosis. In the second case, operated on eighteen months ago, two separate sutures were used, one of which was passed through the upper pole of the kidney and around the last rib, and the other inserted as a large mattress stitch under the capsule and fastened into the abdominal aponeurosis. When the occasion arises again we shall use sutures obtained from the fascia of the back and so avoid the necessity for an incision in the thigh.

## 7. HERNIA.

A thoughtful analysis of the results of the operative treatment of hernia in adults will convince the most sanguine that there is much room for improvement. The percentage of recurrences varies greatly with the experience and skill of the operator, but, even in the hands of the most skilful, recurrences after the closure of large ventral hernias, direct inguinal hernias, and long-standing oblique inguinal hernias are very frequent.

It was in the treatment of these conditions that the transplantation of patches of fascia lata first came into prominence, and for a time it seemed that the difficulties in the way of a cure had been successfully solved. Before long, however, recurrences again began to appear, and ultimately became so frequent that nowadays the method has very few advocates. In explanation of these failures one often hears it said that the transplant has been absorbed. Our researches, however, have led us to the opinion that in the majority of instances this explanation is incorrect, and that the blame for the recurrence of the hernia must be laid to the character of the healing between the transplant and the surrounding tissues. Our experiments on animals resembled very closely the usual method of filling a defect in the abdominal wall with a patch-transplant, or of re-enforcing the line of suture after closure of the opening. The same care in overlapping the edges of the transplant and the surrounding tissues was observed. But the experiments indicated that, although the patch

of fascia continued to live almost unchanged, it healed to the edges of the defect by the flimsiest kind of tissue, and if the line of contact were under strain the edges almost invariably drew apart. This separation of the edges is even more likely to occur in operations on hernia, as operators rarely take the precaution to remove the areolar membranes from the surface of the transplant and the edges of the defect. The adhesion, therefore, can have only the strength of these areolar membranes, and can be of no importance whatever in preventing the separation of the hernial ring.

If one is tempted to use a patch-transplant to assist in the closure of a ventral hernia, one should observe the precaution of scarifying the surfaces of the transplant and of the surrounding tissues which are placed in contact, in order that firm adhesion may take place. In spite of such precautions, however, the surgeon must place his whole trust in the character of the healing which occurs, the strength of which is very uncertain. The light scar-tissue which develops between overlapped aponeurotic surfaces is not equal to the strain which must be resisted in large ventral hernias. There is no probability, therefore, that the use of patches of fascia lata, sewn in with absorbable sutures, will ever be revived again.

**Ventral Hernia.**—Ventral hernia is an ideal condition for closure with living sutures. By their use the uncertainty which attends healing by scar-tissue is totally eliminated and the whole responsibility for a cure placed upon the sutures themselves. There is practically no limit to the number of sutures that may be inserted, so that it becomes simply a matter of the judgement of the surgeon as to how many layers of sutures are necessary to restore the abdominal wall to its normal strength. The chief precautions which must be observed are to see that the sutures are woven securely into the tissues surrounding the opening, and that these tissues, wherever possible, include aponeurosis. It is preferable to make no preliminary dissection of the edges of the hernial ring into their various layers, as the grip of the sutures is most secure when they are undisturbed. If the edges of the ring can be drawn together without too great tension, so much the better; but if they cannot, the gap which is left may be closed by weaving the sutures across the opening as in the darning of a sock.

From our experience with living sutures a few points in technique have been evolved which are useful. Much time can be saved by having a second operator to secure and prepare the sutures. A few minutes before they are required he makes a long incision on the lateral aspect of the thigh and exposes the fascia lata. The fat and areolar tissues are carefully removed with the blade of a scalpel over the whole area from which the sutures are to be taken. A small longitudinal incision is then made through the fascia, and with a pair of blunt-pointed scissors it is ripped to the required length. This will vary from nine to twelve inches according to the length of the thigh. A second incision in the fascia is made a quarter of an inch lateral to the first, and one end of the suture so prepared is cut free and trimmed to a point. This end of the suture is passed through the eye of a large curved needle, and tied securely after transfixion with fine silk. The needles are very thick, and have an eye which is large enough to allow the strip of fascia to enter easily. The terminal end of the suture is then cut free, and a fine linen ligature is tied

around it to prevent splitting. The suture is now lifted from its bed and is ready for use. In taking the first stitch the needle is passed through a tough portion of the edge of the gap to be closed and then through the terminal end of the suture. In this way a slip-knot is produced which forms an excellent anchor. The suture is woven strongly into the edges with as many bites as

seem necessary, and passed backwards and forwards across the opening until its whole length is used up. Owing to the slippery character of the fascia it will be found useful to anchor the sutures at every second or third stitch by some form of knot. We usually combine a single loop-knot with transfixion. When the first suture has been used up a second may be attached to it in the same way as pieces of tennis gut are fastened together, and the sewing continued. In this way one suture after another may be inserted until the opening is completely closed. The suture is finally ended by splitting its terminal portion into two strands which are tied together about the suture in a triple knot. This knot should be made secure by transfixing it with a catgut ligature which will hold its loops in contact until they become firmly healed together. (Fig. 233.)

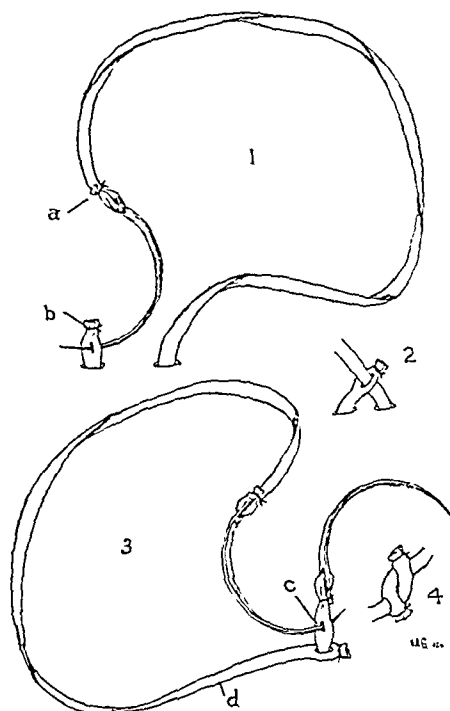


FIG. 233.—Diagrams illustrating points in the technique of using living sutures of fascia.

1, The strip of fascia lata has been tied into a large-eyed needle with fine silk (a), and a similar ligature has been tied around the tail of the suture at b. The needle has been passed through some strong aponeurotic tissue and then through the tail of the suture to form a slip-knot. 2, The slip-knot drawn taut. 3, Method of joining one suture to another. The suture (c) has been used up. The needle of suture d, and the needle of suture c is then passed through suture c. The needle of suture c is cut off, and suture d is drawn taut. 4, The jointing of the two sutures completed.

The wound in the thigh has never given us any concern. Where not more than four sutures have been removed, the opening in the fascia can be readily closed with catgut, and there does not appear to be sufficient strain upon it in the ordinary movements of the thigh to cause it to open again. In several instances, however, so much fascia was used that the opening could not be closed, and in these cases no attempt at closure was made. In not a single patient, of the two hundred or more in whom strips of fascia have been removed

from the thigh, has there been any complaint of symptoms or any evidence of disability resulting therefrom.

The details of the operation for ventral hernia are simple. The sac is dissected free of the edges of the ring, and removed or pushed back without opening it, as seems best at the time. The peritoneum is separated from the abdominal wall in the immediate neighbourhood of the opening in order

that the sutures may be inserted without puncturing it. As already stated, the edges of the hernial ring are not separated into the various layers of aponeurosis and muscle, as it has been found that by so doing the strength of the grip of the sutures is lessened. After securely anchoring the suture in some aponeurotic structure the opening in the abdominal wall is closed by a through-and-through running stitch. Care is taken that each loop of the suture passes through strong aponeurotic tissue, well back from the edges of the opening, so that all possibility of cutting out is avoided. So secure is

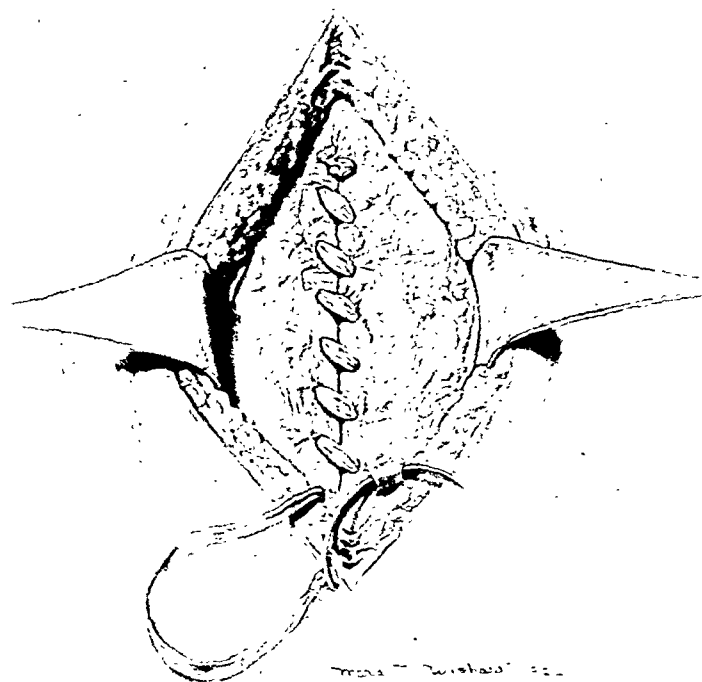


FIG. 234.—Drawing of the repair of ventral hernia with sutures of fascia lata. Insertion of the first row of sutures which brings the edges of the defect together or as nearly together as they will come without great tension.

the closure when performed in this way that in most instances a single row of sutures is sufficient, but when the opening is larger, or the anticipated strain severe, it is well to support the first row of sutures by a second. This is inserted somewhat as in the lacing of a boot. By means of it the strain is distributed widely over the abdominal wall, and the tension on the former defect correspondingly reduced (Figs. 234, 235).

In some of our cases the opening in the abdominal wall has been so large that it was impossible to draw the edges together by any form of suture. In



other cases it was possible to draw them together only at the risk of so increasing the intra-abdominal pressure as to endanger the patient's life. In these patients the edges of the opening were simply drawn as closely together as seemed safe, and the space left was completely filled with a meshwork of sutures. The strips of fascia were so interwoven with one another that no chinks were left through which a hernia could occur. When the healing

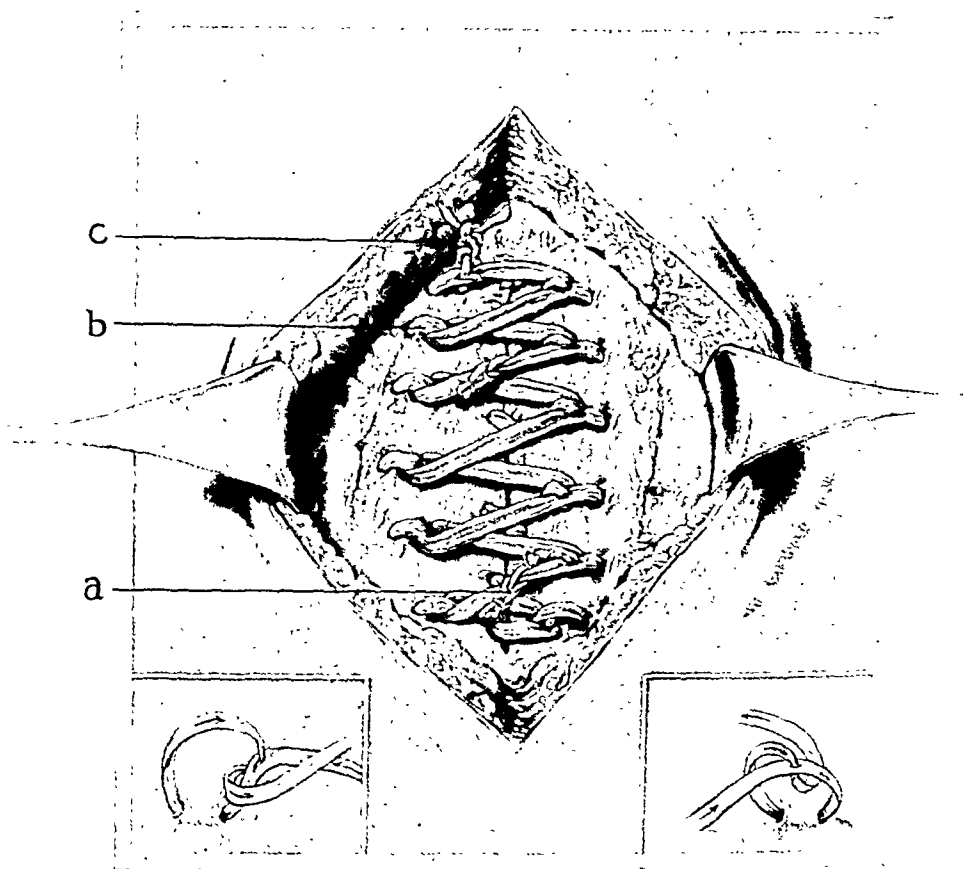


FIG. 235.—Drawing of the repair of ventral hernia. Insertion of second row of sutures. The needle takes deep bites of the aponeurosis at some distance back from the edges of the opening.

*a*, A join between two sutures; *b*, Lock-stitch inserted to prevent slipping; *c*, Triple knot which terminates the suture. It is transfixed with a ligature of fine silk or catgut.

The inserts in the lower corners show methods of making the lock-stitch.

process is complete the abdominal defect is filled with an aponeurotic structure which is comparable with the linea alba.

During the past five years the sutures of fascia lata have been used on many occasions in closing ventral hernias. Most of the cases had been operated upon previously by other methods, and in all the possibility of a permanent closure was doubtful. In some it seemed certain that operative treatment would be futile. So far all the operations have been successful.

In several in which it was impossible to close the gap completely the strands of fascia and the knots can still be felt distinctly through the skin.

**Inguinal Hernia.**—Our attention was drawn to the question of recurrence of inguinal hernia by the large numbers of soldiers who have returned to our military hospitals for treatment of hernias which had already been operated upon once and sometimes several times previously. Many of these patients have come under our direct care, and we have taken the opportunity to study the cause of the recurrence and to attempt to find a remedy for it.

The histories of these patients indicated that some of the hernias had been present from childhood and had been operated upon just previous to enlistment, and that some had developed during service and been treated by operations in military hospitals. In the majority of cases the patients had been kept in bed for three weeks after operation, and had been brought up to class A category by several months of graduated physical training. Little criticism could be offered of the after-treatment.

Our findings at operation showed that a few which originally had been oblique hernias had recurred into the cord. In all probability the sac, in these cases, had never been completely removed. The majority, however, had recurred as direct hernias, irrespective of what the condition had been originally. That direct hernias should recur is not at all surprising, as the records of any hospitals in which this subject has been investigated show that recurrence takes place in from 40 to 50 per cent of the cases, but that hernias which were originally oblique should recur as direct hernias appealed to us as wanting explanation. Unfortunately it is impossible to state definitely from an examination of these patients on the operating table just what was the cause of the recurrence. In most cases the external ring was very large, but whether this was the cause or the result of the recurrence it is impossible to say. In many of the men the hernia had been present for a long time before the original operation, and it may be that the posterior wall of the canal had become so weakened by the dragging of the internal ring towards the external that it was unable to resist the increased abdominal pressure coincident with war-time activities. On the other hand, it may be that the weakening of the abdominal wall has resulted from the original operation in which the fascia transversalis may have been injured or the abdominal muscles destroyed by tight sutures. Whatever the cause of the recurrence, the indications are that in operations for inguinal hernia in adults definite precautions must be taken to leave the abdominal wall medial to the internal ring as strong as it normally should be, and if there is any possibility of the posterior wall of the canal being weaker than normal, it must be supported by some form of plastic operation which is more certain than the ordinary methods of suture.

The defects in these methods of suture were very evident in the cases operated upon. In some the internal oblique muscle had been sutured to Poupart's ligament in front of the cord. In the majority, however, the internal oblique and the conjoined tendon had been sewn to Poupart's ligament behind the cord in an attempt to restore the obliquity of the canal. What may be the relative merits of these two methods of suture it is impossible to say, although theoretically, presuming that the structures which are sewn together stay together after the sutures are absorbed, the latter would seem to be the

more rational. Our findings indicate, however, that it is very problematical whether the structures which are sewn to Poupart's ligament really do stay in this position for any length of time. In every recurred hernia operated upon the internal oblique muscle had separated from Poupart's ligament throughout its inner half, and in some there was no evidence whatever that it had been sewn to the ligament. In not one instance, despite the fact that the records showed that the conjoined tendon and the sheath of the rectus had been sewn to Poupart's ligament with kangaroo tendon or catgut, did we find these structures together at the time of the second operation.

These findings have produced a doubt as to whether the sewing of the muscles and conjoined tendon to Poupart's ligament with ordinary sutures is ever a factor in preventing recurrence of the hernia. Certainly the experiments in which plication of the fascia of the rabbits' backs was performed would indicate that the adhesions of such structures is extremely slight. To investigate the subject further a few experiments were performed in which muscles were drawn out of their normal positions and sewn side-to-side with other muscles and with tendons and aponeurosis. In a very short time after the absorption of the sutures the muscle had returned to its former position, leaving no indication that an operation had been done. If, before inserting the sutures, all areolar membranes were removed from the surfaces which were placed in contact, and particularly if these surfaces were scraped and scarified, the amount of adhesion was greater; but if the normal action of the muscle tended to produce definite strain on the line of suture, the scar-tissue soon became stretched and the intention of the operation defeated. These results demonstrate the folly of dragging structures such as the abdominal aponeurosis, the conjoined tendon, and the sheath of the rectus out of their normal positions to suture them to Poupart's ligament in the hope of permanently strengthening the abdominal wall.

*Direct Inguinal Hernia.*—In the case of direct inguinal hernia the defect in the ordinary Bassini operation has frequently been recognized, and many attempts have been made to improve on this operation by filling the defect in the abdominal wall with muscular or aponeurotic structures which might be able to withstand the strain. Thus, the transplantation of a portion of the rectus muscle to Poupart's ligament, the turning down of flaps of the rectus sheath, and the transplantation of patches of fascia lata have all had their advocates. These operations all have the defect, however, that they depend for their success on the healing together of fibrous or muscular structures, a factor which unfortunately cannot be depended upon. None of them, therefore, has ever become recognized as the established method of procedure.

The structures about the inguinal canal are peculiarly suitable for the use of living sutures. No dependence can be placed on a muscle such as the internal oblique, but in the immediate neighbourhood are the abdominal aponeurosis, the conjoined tendon, the sheath of the rectus, and Poupart's ligament, all strong fibrous structures which will give firm anchorage for the suture. With a sufficient number of strips of fascia lata, therefore, the weak spot in the abdominal wall can be filled up completely without any disturbance of the normal anatomical relations and without any dependence on the uncertain process of healing.

The operation for direct inguinal hernia presents no difficulties. The incision is made so as to allow perfect exposure of the spine of the pubes and the insertion of the conjoined tendon and the rectus sheath. After splitting the external oblique, the upper leaf is reflected until a good view is obtained of the white abdominal aponeurosis. The sac is dealt with in the usual manner, although occasionally we have done nothing with it more than to push it backward out of the way. The first suture of fascia lata, a quarter of an inch wide, is then anchored securely into the rectus sheath close to its attachment to the pubic bone. The needle is now passed behind the spermatic cord to pierce Poupart's ligament at its insertion into the pubic spine. If possible it should be made to pick up the periosteum to make the security of its fixation more certain. When the suture is drawn taut, the weakest spot in the abdominal wall, namely, that which lies behind the external abdominal ring, is filled with a tough aponeurotic tissue which effectively prevents any bulging through the ring. The sewing is continued in an outward direction, drawing the internal oblique muscle to the reflected portion of Poupart's ligament behind the cord, until the position of the internal ring is reached. Here the suture is locked and then carried to the outer side of the ring, where a supporting stitch is inserted. In this way the cord, at the point where it disappears through the abdominal wall, is surrounded by a fibrous ring which will effectively prevent the development of a hernia at this point. By locking each stitch at this stage the possibility of undue constriction of the cord is prevented. The sewing of the internal oblique muscle to Poupart's ligament in this manner is a detail of the operation which in our opinion is of very little value in preventing recurrence of the hernia. It is of value, however, in permanently covering the peritoneum with a thick layer of muscle which will prevent the protrusion of peritoneum through the chinks of the next layer of sutures, which is the important one in the prevention of recurrence. This layer commences as a continuation of the first, at the outer side of the internal ring. The needle takes a solid bite of the abdominal aponeurosis at its point of fusion with the external oblique and is then passed behind the cord to pick up Poupart's ligament. The suture is carried backward and forward across the space, with frequent lock-stitches, until the sheath of the rectus is reached, and this also is woven to Poupart's ligament until the whole space is filled with fascia down to the pubic spine. No attempt is made with the second row of sutures to drag the abdominal aponeurosis and the rectus sheath out of their normal positions. No greater tension is exerted on the sutures than is sufficient to make them lie flat. The whole idea of the operation is to fill the weak spot in the abdominal wall with what may be called a filigree of living aponeurosis, and to depend on the strength of this filigree and on its grip on the surrounding tissues for the cure of the hernia. What one does with the external oblique is of relatively little importance. Usually in direct hernia it is too weak to be of any value to the surgeon. In our earlier operations we closed it down to the external ring with a narrow strip of fascia, but in the last four years we have simply sewn it up with catgut. The time which is spent in preventing a hernia from getting out of the canal is much better spent in preventing it from getting into it. (*Figs. 236, 237.*)

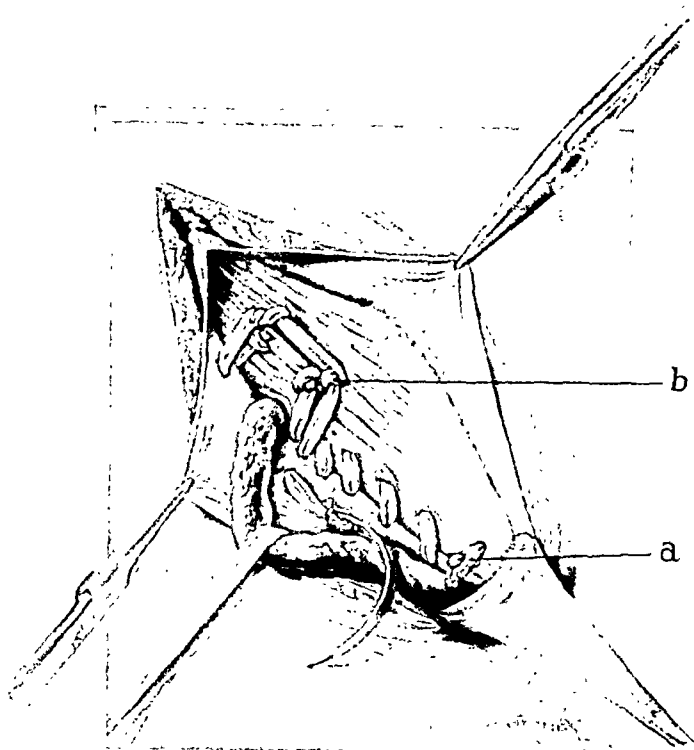


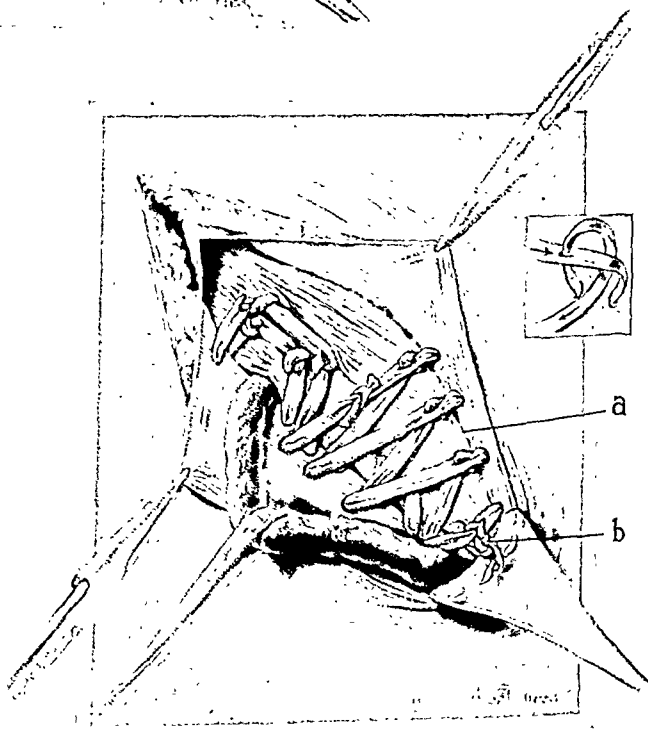
FIG. 236.—Drawing of the repair of an inguinal hernia with sutures of fascia lata. Insertion of the first row of sutures which brings the internal oblique and conjoint tendon into contact with Poupart's ligament, and reinforces the internal ring.

*a*, Slip-knot anchoring stitch; *b*, Lock-stitch.

FIG. 237.—Drawing of the repair of an inguinal hernia. Insertion of second row of sutures between the abdominal aponeurosis and Poupart's ligament. These structures are not drawn together, but the interval between them is filled in with a filigree formed by the fascial suture.

*a*, The line of junction of the aponeuroses of the internal and external oblique muscles in the abdominal aponeurosis; *b*, Termination of suture.

The insert shows the most useful form of lock-stitch.



*Oblique Inguinal Hernia.*—Oblique inguinal hernia rarely requires special attention to the closure of the abdominal wall. The cure of the hernia, particularly in children and young adults, depends on the complete removal of the sac. In these patients the posterior wall of the canal is normal, and if it is not damaged during the operation, should prevent the development of another hernia. Our researches on the healing of muscle to aponeurosis, and of aponeurosis to aponeurosis, and our observations on the patients in whom hernias have recurred, have led us to think that the internal oblique muscle and the conjoined tendon when sewn to Poupart's ligament rarely stay in the new position. The cures are accomplished in all probability quite irrespective of the attempt to close the supposed abdominal defect.

In many oblique hernias, however, the posterior wall of the canal is not normal. The constant passage of intestine and omentum into the sac gradually changes the narrow entrance of the tunica vaginalis into a wide funnel-shaped opening which materially stretches and weakens the fascia transversalis. The simple removal of the sac in these cases, therefore, leaves the posterior wall of the canal very weak and quite unfit to withstand unusual intra-abdominal pressure. This is true also, in even greater degree, in those cases in which the chronicity of the condition has resulted in the displacement of the internal abdominal ring to a position directly behind the external. These are the cases which call for some form of repair of the abdominal wall.

The operation for oblique hernia is identical with that already described for direct hernia. When it is completed the weak posterior wall of the canal is supported by a permanent meshwork of fascia lata which is sufficient, we believe, to withstand all variations of abdominal strain.

**Femoral Hernia.**—This form of hernia is a condition which should lend itself well to treatment with sutures of fascia. Unfortunately our experience with the method is limited to one case, so that we are not in a position to draw conclusions. This patient was a woman who had previously been operated upon for femoral hernia but had suffered a recurrence some months later. Our operation consisted of the removal of the sac through an inguinal incision, and the suturing of Poupart's ligament to Cowper's ligament with a suture of fascia lata. The suture was not drawn very tight, as it was not the intention to induce fusion of Poupart's ligament to the pubic bone, but rather to leave the former in its normal position and simply shut off the entrance of the crural canal with fascia. In this way the outer edge of Gimbernat's ligament, which bounds the inner margin of the femoral ring, was advanced in an outward direction by means of the fascia lata, to form the inner boundary of the compartment of the canal occupied by the vein. This operation has so far proved successful.

The treatment of femoral hernias by suture with catgut is by no means certain of success. In all probability the part of the operation which is the most important in accomplishing a cure, in those patients that are cured, is the removal of the sac. The insertion of a catgut suture from Poupart's ligament to the pectineal fascia through a femoral incision, or the suturing of Poupart's to Cowper's ligament through an inguinal incision, can have little effect in producing a permanent closure of the femoral ring. Certainly in the recurred cases which we have seen there has been very little evidence

to show that such suturing had been done. The substitution of fascia for catgut should remove this uncertainty and materially reduce the number of recurrences.

The results of the living suture operation in hernia have been very satisfactory. We now have records of over 100 hernias of all varieties which have been treated by this method over a period of five years, and, up to the present, there have been no recurrences. The majority of the patients had been operated upon previously by other methods, and many had been operated upon several times. The most gratifying results were obtained in the recurred direct hernias, which have hitherto presented a baffling surgical problem. We have no doubt that recurrences among these cases will occasionally appear, for defects in the anchoring of the sutures will sometimes be unavoidable; but if care is exercised in choosing only strong aponeurotic structures for the passage of the suture, and in anchoring it securely at its beginning and end, recurrences will undoubtedly be rare. Even suppuration is not an irreparable disaster, as three of our cases became mildly infected, but without extrusion of the suture or injurious effect on the ultimate result of the operation.

The method is recommended in the following conditions: (1) Direct inguinal hernia; (2) Oblique inguinal hernia in patients at or beyond middle age, particularly when the canal has lost its obliquity and when the abdomen is becoming pendulous; (3) All forms of recurred hernia; (4) All ventral hernias in which there is any doubt in the surgeon's mind as to the permanence of closure by the ordinary methods; (5) Ventral hernia in which closure can be obtained only with disquieting increase of intra-abdominal pressure—in these cases the edges of the hernial ring may be left apart and the space filled with a meshwork of fascial sutures.

### CONCLUSIONS.

1. In the repair of certain anatomical defects the transplantation of fascia, aponeurosis, and tendon is a valuable surgical procedure.
2. Transplants of these tissues when given an adequate supply of lymph continue to live practically unchanged.
3. They heal to whatever structures they are placed in contact with by ordinary scar. The strength of this scar depends on the degree to which the surfaces which are in contact are denuded of areolar tissue and scarified, and on the area of these surfaces.
4. The employment of these tissues as transplants in the form of sutures removes the element of chance which attends healing by scar-tissue.

## SUBMAXILLARY SALIVARY CALCULUS.

BY HAMILTON BAILEY, LONDON.

SALIVARY calculus, the Cinderella of the stones to which human secretory and excretory mechanisms are heir, owes its lowly position in the surgical estimation to the fact that it is never a direct cause of death. Sometimes, however, it is a source of much pain and very considerable inconvenience.

The populace of the East End of London (as revealed by the practice of the London Hospital) are rarely afflicted with stone in the parotid gland or its duct; nevertheless submaxillary salivary calculus is relatively frequent, the ratio being a little more than 50 to 1. Christopherson<sup>1</sup> observes that, in the Sudan, parotid are much commoner than submaxillary calculi.

This paper is founded upon 32 cases of stone in the submaxillary salivary apparatus which have, with the exception of one case, been collected from the out-patient department and the records of the in-patient department of the London Hospital.

**Composition and Etiology of the Calculi.**—Chemical analysis has shown that submaxillary stones and the 'tartar'<sup>11</sup> which collects upon the teeth are almost identical in composition. Both are mainly composed of phosphates and carbonates of calcium, together with small quantities of calcium fluoride and magnesium phosphate, and an occasional trace of sulphocyanide of potassium. These are combined in both instances with about 7 per cent of animal matter. Similarly the bacteriological<sup>5</sup> examination reveals that both are swarming with micro-organisms.

It has been suggested that salivary calculus is due to a foreign body finding its way down the salivary duct. In support of this view a fish-bone has been seen in the centre of a calculus removed from Wharton's duct, and a feather<sup>3</sup> causing obstruction has been picked out of Stenson's duct. Nevertheless these rare instances prove no more than the hair-pin, pieces of catheter, or other foreign body occasionally found within a stone of the bladder. Salivary calculus is an irreversible colloidal adsorption compound sharing with its more illustrious sisters, renal, biliary, pancreatic, and prostatic stones, a certain degree of indefiniteness as to precise etiology.

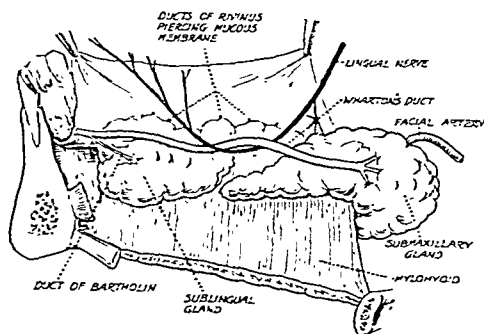
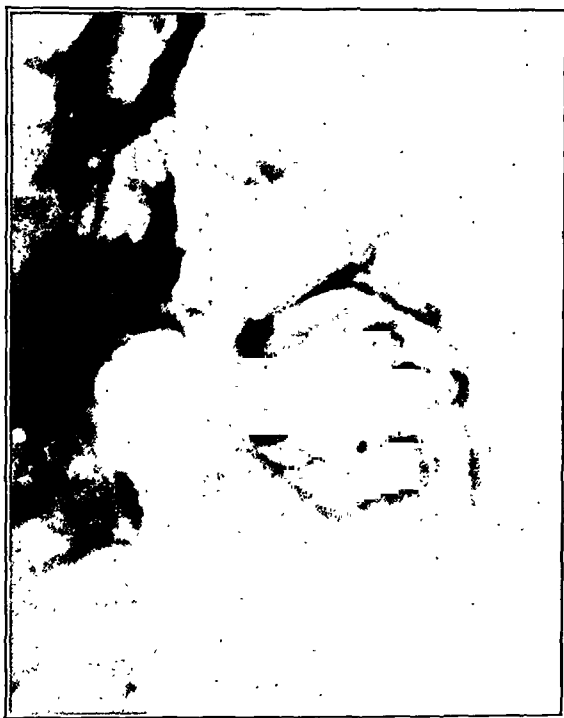


FIG. 238.—Dissection to show Wharton's duct and the structures in relation to it. (After Allen Thompson.)



**Some Points in the Surgical Anatomy and Physiology of the Submaxillary Gland.**—The submaxillary gland, riding astride the posterior free border of the mylohyoid, is divided into two portions: a cervical which occupies the submaxillary triangle of the neck, and a buccal which lies beneath the mucosa of the floor of the mouth. The cervical portion constitutes more than two-thirds of the total gland.

The relationships of the buccal lobe are shown in *Fig. 238*. Wharton's duct, traced backwards, will be seen to divide at the hilum into three primary divisions. These divide and subdivide to drain the 1500 lobules<sup>4</sup> which constitute the parenchyma. A section through the ampulla of Wharton's duct is shown in *Fig. 240*, and *Fig. 241* is a similar section midway down the same duct. A notable feature in



*Fig. 239.*—Stones in the submaxillary gland.

the structure of the duct is the complete absence of musculature. One may therefore surmise that the passage of a stone along the duct, or, indeed, the normal ejection of saliva, must be accomplished by the pressure of the secreted saliva within the gland, aided perhaps by contraction of the muscles which constitute the floor of the mouth. This pressure is considerable. Leonard Hill<sup>7</sup> has demonstrated that, if a manometer is tied into Wharton's duct, the pressure registered when the gland is in full activity may be greater than the arterial blood-pressure.

#### **Clinical Features.**—

*Sex.*—Males were nearly three times more commonly affected.

*Age.*—The age varied between 16 and 65.

Calculi may be present in the submaxillary gland and produce no symptoms. In this respect they may be compared with 'silent' renal and biliary stones. *Fig. 239* shows calculi found accidentally in a radiographic examination. There were no symptoms referable to the stones, and there were no signs when the submaxillary glands were palpated.

*Spasmodic Pain* ('coliques salivaires' of the French authors) typically occurs at the commencement of a meal. In more than 40 per cent of the cases in which pain was a feature the patient stated that it occurred before or (more often) during mastication. This pain is often severe, and it is described by the patients as like toothache.

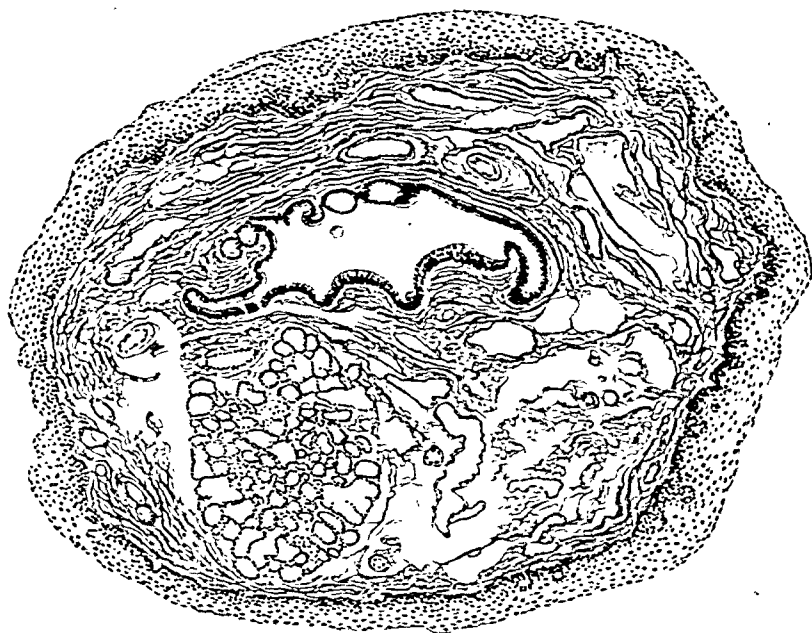


FIG. 240.—Transverse section through the ampulla of Wharton. (A prolongation of the sublingual gland into the papilla is shown.)

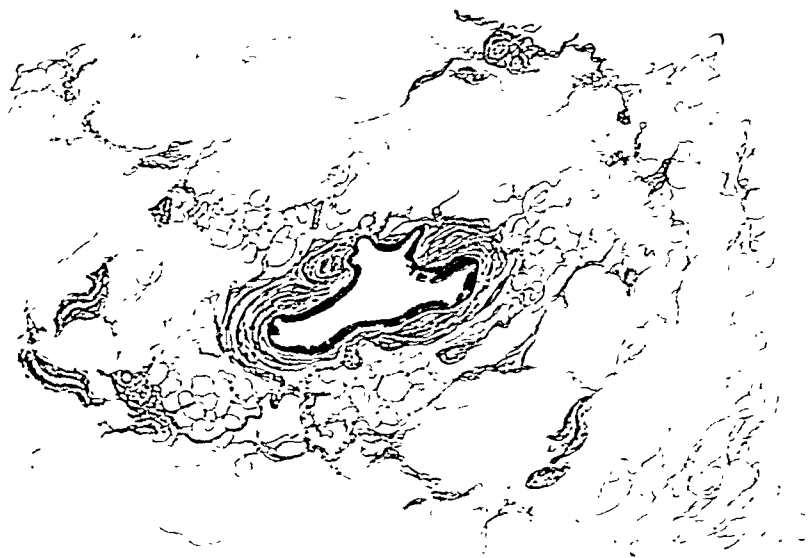


FIG. 241.—Transverse section through the middle of Wharton's duct. Sections stained with van Gieson and iron hæmatoxylin. There was no muscle demonstrable in the sections of Wharton's duct examined.

*As a Cause of Lingual Neuralgia.*—The intimate relationship of the lingual nerve to Wharton's duct explains the fact that the pain which accompanies the passage of a submaxillary stone may be referred to the tongue. In the case of a female of 22 under observation, this referred pain was described as "like a needle shooting down the side of the tongue". In this case the calculus was passed spontaneously.

*A Swelling Beneath the Mandible* is often a leading feature of the case. Variations in the size bearing a relationship to meals is pathognomonic of this condition.

*Case 1.*—A barber, age 61. For forty years he had noticed a swelling in the right submaxillary region, "most noticeable after eating gooseberries or anything tart". For four months the swelling has been larger and very painful. A large salivary calculus was removed from the posterior portion of Wharton's duct.



FIG. 242.—A method of palpating the submaxillary gland.

*A Swelling in the Floor of the Mouth.*—This is not commonly the chief complaint of the patient. It usually signifies that the stone is just behind the ampulla of Wharton's duct.

In general, it may be said that an aggravation of the symptoms owing to secondary infection is the most important factor in determining the patient to seek relief.

#### Physical Examination.—

The orifices of Wharton's ducts are inspected with the aid of a pocket torch, and the two sides compared. In a large number of cases of salivary calculus there is some aberration in the orifice of the affected side. In cases where secondary infection has supervened, the ampulla is inflamed, and sometimes pus

can be seen exuding from the duct. Very occasionally a stone impacted in the ampulla will be observed (*Fig. 243*).

A dry swab is inserted under the tongue, and a pinch of salt or, better, some lemon-juice is placed upon the dorsum. The patient is then asked to move the tongue about until he tastes the substance introduced, keeping the swab in place with his finger. He now opens his mouth and rotates the tongue upwards and backwards. The swab is removed, and the dried floor of the mouth again inspected in a strong light. Saliva can be seen flowing, occasionally being ejected, from Wharton's ducts. In cases of calculus impacted in Wharton's duct there will be little or no secretion from the affected side (*Fig. 243*).

## SUBMAXILLARY CALCULI

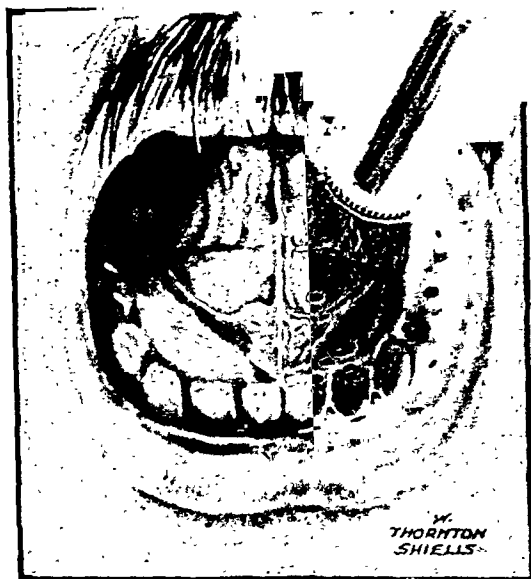
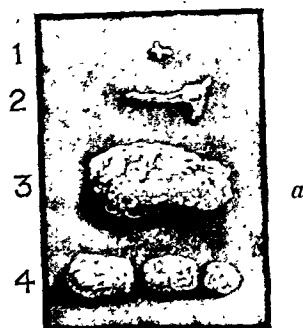


FIG. 243.—*a*, Specimens of calculi. 1, Calculus extracted from the ampulla of Wharton. 2, Calculus found in the hilum of the submaxillary gland after removal of the gland. Its shape suggests that a foreign body lies within. (Specimen kindly lent by Sir Hugh Rigby.) 3, Calculus removed from the posterior third of Wharton's duct. 4, Calculi extracted after slitting up Wharton's duct.

*b*, Stone impacted immediately behind the orifice of the right duct of Wharton. The patient is a man of 47. He is sucking a piece of gauze soaked in lime juice, which was placed upon the dorsum of the tongue. At the same time a dry swab was inserted under the tongue. This has just been removed, and a pocket torch illuminates the floor of the mouth. Saliva is flowing from the left Whartonian orifice and is beginning to collect in the sulcus to the left of the frenum linguae. The corresponding sulcus of the right side remains dry, for the duct is blocked by a tiny stone which can be seen shining through the mucosa.

As the submaxillary gland is composed of two portions, one above and one beneath the mylohyoid muscle, there can be but one efficient method of examining the whole gland, and that is by bimanual palpation (*Fig. 242*).

If, in a case of a doubtful enlargement in the submaxillary triangle, it is ascertained that there is a contiguous intrabuccal and cervical swelling, this is good evidence that that swelling is an enlarged submaxillary salivary gland.

A stone in the anterior two-thirds of Wharton's duct is easily palpated, and can readily be shown by an X-ray through the floor of the mouth; it is passed spontaneously in a fair percentage of cases, and in the remainder it can be extracted with comparative ease. A stone impacted in the posterior third of the duct is much more difficult to detect clinically, to show radiographically, and to treat effectively. Attention is therefore especially directed to palpation of the posterior third of Wharton's duct.

*A Method of Palpating Wharton's Duct.*—The patient's head is flexed and inclined slightly to the affected side in order to relax the musculature. The index finger is inserted into the mouth, the pulp of the finger being placed upon the internal alveolus. The finger is passed backwards, following the alveolus until the extreme posterior extremity is reached. The finger (now insinuated between the alveolus just behind the last molar tooth and the side of the posterior third of the tongue) is rotated through a right angle, so that the pulp of the finger is directed downwards. In conjunction with the fingers of the other hand beneath the jaw, the whole course of Wharton's duct is palpated from behind forward. In about one out of four patients this manœuvre brings on retching, but even in this event the valuable information required is elicited before any severe discomfort is experienced.

The sounding of Wharton's duct has a limited field of usefulness. It is sometimes of value in the type of case depicted above. Bowman's nasal-duct probe and a urethral guide are the instruments best adapted for the purpose.

### Differential Diagnosis.—

1. *From Peridental Suppuration.*—Patients suffering from salivary calculus often attribute their pain to toothache. Selby<sup>10</sup> records that nine cases of salivary calculus were referred to him as dental root abscesses for radiographic examination.

2. *From Cervical Lymphadenitis.*—The swelling in the submaxillary triangle (due to an enlarged cervical portion of the submaxillary salivary gland) is liable to be mistaken for submaxillary cervical lymphadenitis. The differential diagnosis between enlarged submaxillary lymphatic glands and the submaxillary salivary gland lies in bimanual palpation.

Case 2.—Female, age 38. Fifteen months previously she had an attack of 'neuralgia'. She visited a dentist and had two teeth extracted (right). Soon after a lump appeared under (right) lower jaw. For one year this has been treated by painting with iodine. Bimanual palpation showed the swelling to be the cervical portion of the submaxillary gland, the buccal portion being similarly enlarged. X-ray examination revealed a calculus in the extreme posterior portion of Wharton's duct.

3. *From a Neoplasm of the Submaxillary Gland.*—The type of case in which this differential diagnosis has to be made is the elderly individual with a mass of stones in the gland itself. The age of the patient, the stony hard

consistency of the gland, the irregularity of the contour, all help to strengthen the suspicion of malignancy.

The prostate gland may be taken as a parallel example. The differential diagnosis between prostatic calculi and carcinoma is sometimes impossible by clinical methods. Radiography, both in the case of the prostate and the submaxillary gland, has to a very large measure cleared up this difficulty.

In the same way light is often shed upon that even more perplexing problem, the differential diagnosis of submaxillary stones from a mixed tumour of the submaxillary gland.

When acute inflammation supervenes in a case of duct obstruction due to salivary calculus, the following conditions enter the clinical picture.

1. *Simulating Acute Primary Parenchymatous Glossitis.*—Stephen Mackenzie,<sup>9</sup> in 1881, reported a case of a lad sent from Victoria Park Chest Hospital to the London Hospital with respiratory obstruction due to an acute enlargement of the tongue. The patient was given ice to suck, and provision was made for immediate tracheotomy should this measure prove necessary. The following morning the pain and swelling had considerably diminished, and the patient produced a salivary calculus which he had extracted from his mouth during the night.

W. H. Haskin<sup>6</sup> records the case of a female, age 42, who sought relief for an enormous swelling of the tongue and enlarged glands of the neck, accompanied by fever. Three incisions were made into the dorsum of the tongue. Later, as the swelling did not abate, four more incisions were made. Finally, after the acute symptoms had subsided, a large calculus was found in Wharton's duct and removed therefrom.

2. *Simulating Ludwig's Angina.*—The following case is included in this series :—

Case 3.—Clerk, age 35, was admitted during September, 1921, into Liverpool Royal Infirmary. For two days he had had pain in the neck and difficulty in opening the mouth. On examination there was a brawny swelling of the neck, and pyrexia. Multiple incisions were made into the subcutis of the neck. Later, whilst the patient was convalescing, he spat out two fragments of calcareous material which proved to be a fractured submaxillary salivary calculus.

Three weeks after leaving hospital he was again troubled by a swelling in the neck. This time the symptoms were aggravated by the taking of food, and the swelling was confined to the right side beneath the mandible. He was again admitted, and the submaxillary salivary gland was extirpated.

Certain cases of peritonsillar abscess invade the submaxillary region and infiltrate the tissues beneath the angle of the jaw. Therefore, when dealing with the type of case under consideration, peritonsillar abscess should always be excluded.

### Complications.—

*Infection.*—Calculi must produce stasis of the salivary flow. Consequently retrograde secondary infection is likely to, and almost invariably does, supervene. Acute spreading infection is a potential danger as long as there is a stone present in the salivary apparatus. In the six cases in this series where the gland was extirpated, histological examination showed chronic inflammation and fibrosis.

**Carcinoma.**—Carcinoma of the submaxillary gland is exceedingly rare. Up to the end of 1923 there were only twenty cases on record.<sup>2</sup> There is very little evidence to show that calculi predispose to this condition.

**Stricture of Wharton's Duct.**—This gives rise to symptoms identical with obturation by calculus. The stricture may follow suppuration around a calculus; probably, however, it is more frequently a sequela of extraction of the calculus from the duct, especially if the incision into the duct is not longitudinal.

**Case 4.**—Female, age 31. Twenty-four months ago a salivary calculus was removed through the mouth. Since then there had been intermittent attacks of salivary colic and swelling of the submaxillary gland.

The duct was catheterized, but this gave no relief. Later, the anterior portion of the duct was slit up, but the symptoms soon returned. The gland was therefore extirpated. No calculus was found.

Pathological report: Chronic inflammation of submaxillary gland.

Occasionally this stricture supervenes upon conditions other than calculus. Wharton's duct can usually be traced lying over the anterior aspect, but taking no part in the formation, of a ranula. This relationship renders Wharton's duct liable to injury during the excision of a ranula.

**Case 5.**—Male, age 20. Typical large unilateral ranula, treated by cutting away anterosuperior wall, evacuating contents, and scraping the remainder of the sac. A few weeks later "the submaxillary gland used to swell up to an enormous size, and the patient was temporarily unable to eat". The case has been lost sight of.

**Radiology.**—Submaxillary salivary calculi, being rich in mineral salts, usually cast a good X-ray shadow, but, as in other forms of calculi, the density

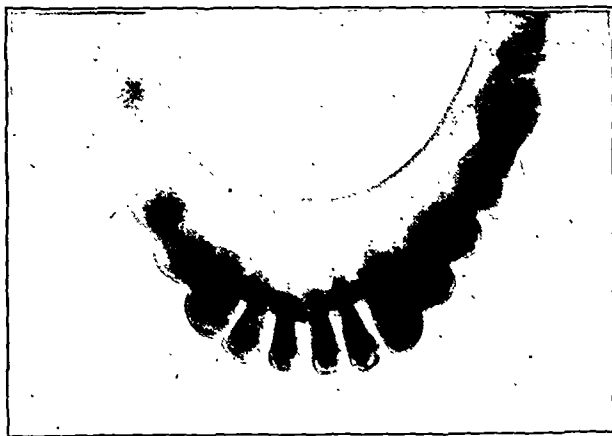


FIG. 244.—Stone in anterior third of Wharton's duct.  
(M. H. Jupe.)

of the stone varies. Rays directed from beneath the chin on to a plate or a dental film within the mouth demonstrate a stone in the anterior two-thirds of the duct; but as a stone in this situation is usually found readily by clinical methods, the X-ray picture is often a matter of academic interest only. A stone in the posterior third of Wharton's duct, especially at its junction with the submaxillary gland, is, as has been shown, sometimes a difficult clinical

problem. It is in these cases, and in stones of the submaxillary gland itself, that an X-ray is almost indispensable. The lateral X-ray is the only reliable method of demonstrating a calculus in these situations. Even when a stone is demonstrable in the anterior two-thirds of the duct, a lateral X-ray to eliminate other calculi further back would prove a highly satisfactory measure.

*Fig. 244* shows a stone in the anterior two-thirds of Wharton's duct; *Fig. 245* a lateral X-ray of a stone in the posterior third of Wharton's duct—'the difficult position'; *Fig. 239* multiple calculi in the submaxillary gland.

### Treatment.—

1. *Expectant Treatment.*—In three cases under observation in this series, to the patient's surprise and relief a stone was passed spontaneously.

Expectant treatment consists in ordering a simple mouth-wash and examining the patient at intervals. Antispasmodics may be administered, but, observing that there is no musculature in the walls of Wharton's duct, only a general sedative action can be expected. Belladonna should be avoided, for it inhibits the secretion of the salivary glands—the motive power which drives the calculus onward.

Expectant treatment is especially indicated when there are no signs of suppuration in a case of a calculus not larger than an orange pip, situated in the anterior two-thirds of Wharton's duct, and X-ray examination has shown this calculus to be solitary.

### 2. *Slitting up Wharton's Duct.*—

This can be accomplished under local anæsthesia. The indications are:

(a) Stone in the anterior two-thirds of the duct after expectant treatment has failed. (b) Stone in the anterior two-thirds of the duct with severe secondary infection. (c) 'Ball-valve' stones of the posterior third of the duct. An example of this was seen in a patient who had a stone in the posterior third of Wharton's duct, in whom expectant treatment failed. On the

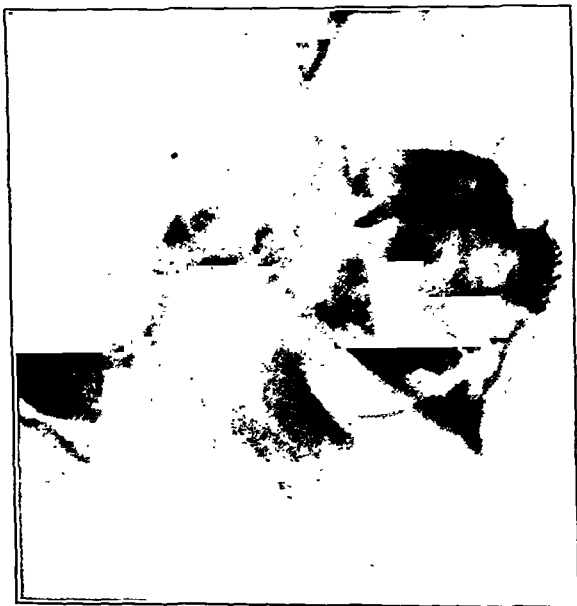


FIG. 245.—Calculus in commencement of Wharton's duct.  
(G. Vilvandré)

day elected for the removal of the stone it had apparently slipped back into the gland, for it was no longer palpable. In such a case, after the duct has been slit up, expectant treatment controlled by radiology is again instituted.

3. *Treatment of a Stone Impacted in the Posterior Third of Wharton's Duct.*—Occasionally a stone in this position is difficult to remove. Local anæsthesia is unsatisfactory in these cases. A general anæsthetic through a Junker should be administered. Doyen's mouth gag is placed in position on the non-affected side. Swabs, such as are used by dentists, inserted within the cheeks, are of value to minimize the collection of saliva. A suction apparatus would prove an ideal method of keeping a clear field. A stitch



through the anterolateral part of the tongue is a good retractor of this organ, which tends to occlude the view. A head light is an advantage.

It is first of all essential to 'fix' the stone. This may be accomplished by one of the following methods:—

a. Lane's tissue forceps are applied in such a way that the teeth close upon the tissues beneath and behind the stone within the duct.

b. A stitch is passed behind and beneath that part of the duct containing the calculus. A curved needle on a holder is used; but the needle should previously have been passed through a flame in order to remove the temper. If the needle breaks in this confined space it is difficult to extract the fragments. The needle which has had the temper removed has the additional advantage that it can be bent to such an angle as to suit the particular case.

c. The stone may be fixed by pressing it against the mandible (C. B. Lockwood<sup>8</sup>).

An incision is now made over the stone, keeping as nearly as possible to the long axis of the duct, in order to avoid subsequent stricture. The stone is best extracted with the aid of a scoop: forceps tend to crumble these soft calculi.

4. *Extirpation of the Submaxillary Salivary Gland.*—A satisfactory incision for this operation is that for ligature of the lingual artery. The indications are: (a) Multiple calculi within the gland giving rise to symptoms; (b) Long-standing cases of obstruction due to a Whartonian calculus, especially if the calculus is a recurrence; (c) Chronic inflammation of submaxillary gland which has persisted after removal of the stone which caused it; (d) Stricture of Wharton's duct after dilatation has failed.

The results of this operation are highly satisfactory. There is no instance in the records of the London Hospital of calculus recurring in the remaining salivary glands, and the patients are in no way inconvenienced by the loss of a submaxillary gland.

I beg to thank the members of the staff of the London Hospital for the many advantages I have been afforded. I am also greatly indebted to the sister in charge of surgical out-patients, without whose help the material for this paper could not have been collected.

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# STRUCTURAL VARIATIONS IN THYROID METASTASES IN BONE, WITH REFERENCE TO BENIGN METASTATIC GOITRE.

By F. GORDON BELL, EDINBURGH.

MUCH interest is attached to secondary thyroid tumours of bone, especially the variety which appears to present a normal or benign thyroid structure. The interest is still greater when the thyroid gland presents, or appears to present, no departure from the normal detectable on physical examination, or at most is the seat of a colloid or adenomatous change. Such cases have been interpreted in the past, chiefly through the influence of Cohnheim,<sup>1</sup> as examples of metastasis from a normal or benign thyroid—*benign metastatic goitre*; and if this interpretation be accepted, it allots to the thyroid a unique place in the range of surgical pathology, for no other structure has been credited with a like potentiality. It seems necessary, therefore, to weigh the evidence which may be taken to support Cohnheim's conception, and this may be considered under the three following heads:—

1. *Certain structural and functional features* of the thyroid gland require consideration as having a possible bearing on the problem. Ewing<sup>2</sup> points out in a general review of the principles of thyroid pathology that the gland possesses a remarkably abundant blood-supply capable of great variation, the circulation between the alveoli is of a sinusoidal character, and the glandular epithelium is brought into an unusually intimate relation to the vascular endothelium owing to the absence of a basement membrane. Great variations in function are closely related to these structural peculiarities, and in response to various stimuli the glandular cells may undergo enormous hyperplasia, as in toxic exophthalmic goitre, where the richness of the cell content may approach or surpass that of many frankly malignant tumours, and under certain conditions may return towards the normal, while under other circumstances the glandular epithelium may atrophy, and regenerate later. Consequently, it may be assumed that the thyroid cell proper possesses exceptional potentialities with regard to size, number, and functional activity, and in virtue of these attributes may possibly be rendered more mobile owing to its intimate relation to the endothelium of the sinusoidal blood-spaces through the absence of a basement membrane, and may thus pierce the slender barrier and enter the blood-stream. Once having entered the circulation, it is easy to suppose that such emboli, composed of normal or abnormal thyroid cells, may readily be deposited and grow in other parts, for the exceptional capacity of thyroid tissue to survive and to function in new surroundings is amply demonstrated by the success attending thyroid grafting. In this connection it will be interesting to observe whether grafts of admittedly normal thyroid tissue—placed, for example, in the head of the tibia, which is a popular site for

grafting at present—display any future tendency to erode the bone and to act in a malignant fashion as the so-called benign thyroid metastasis commonly does.

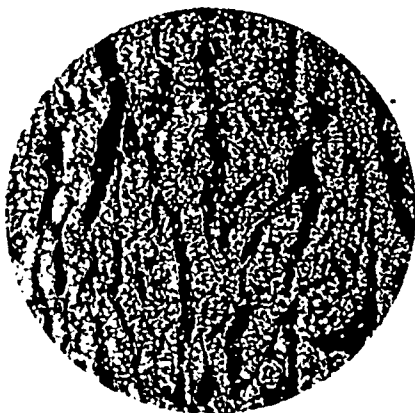


FIG. 246.—Foetal adenoma. Reproduced to show the sinusoidal character of the circulation.

It is convenient here to refer to certain other histological and developmental features. The thyroid possesses a reserve supply of undeveloped glandular epithelium which, in response to a physiological call, may develop and assume adult characters. Some pathologists, especially Wölfler, have allotted great importance to these reserve islets, sometimes called Wölfler's rests, and hold them responsible for the development of thyroid adenomas, which in turn may give rise to metastasis, benign or malignant. Whatever be the rôle of these islets, it is an undoubted fact that secondary thyroid tumours in bone often display a structure closely resembling that of the foetal or developing

thyroid or of the foetal adenoma. The sinusoidal character of the circulation is often particularly observable in adenomata (Figs. 426, 247), and the endothelial lining of the blood-spaces may be so attenuated that the alveoli appear to be literally bathed in blood. This feature is exaggerated in the malignant adenoma, and accounts for the fact that the dissemination of thyroid carcinoma usually takes place by the blood-stream. It is conceivable that an imperfection of the sinusoidal endothelium, possibly aided by, or associated with, some slight trauma or strain, may allow the glandular cells in benign conditions of the thyroid to enter the circulation and give rise to a benign metastasis. Patel,<sup>3</sup> in a paper entitled "Tumeurs benignes du Corps thyroïde donnant des Metastases", appears to attach importance to the peculiarities and richness of the capillary circulation, and notes the valve-less condition of the thyroid veins, especially the inferior set.



FIG. 247.—Colloid adenoma. Reproduced to show the tenuity of the sinusoidal endothelium. The darkly-staining spindle cells are seen here and there round the large alveolus, but are not detectable round the small alveoli, which are surrounded by blood-corpuscles.

2. *Errors in development* and the osseous inclusion of aberrant thyroid

tissue offer a plausible explanation for some benign tumours apparently unassociated with changes in the cervical thyroid. Such an explanation may hold in the region of the neck in regard to the mandible, sternum, clavicle, and possibly the cervical spine. Radley and Duggan<sup>4</sup> invoke the aid of this theory in the case of a tumour of the clavicle, though a small tumour had been removed from the thyroid two years previously. Possibly Riedel's<sup>5</sup> case, a tumour of the mandible recurring ten years after removal, might be similarly interpreted. 'Accessory thyroids', or misplaced islands of thyroid tissue, may be situated along the line of the thyroglossal tract, behind the sternum or clavicles, and towards the spine, and may conceivably be included in one or other of the bones mentioned, though there are certain anatomical objections. Such an origin can hardly be alleged in the case of the long bones, pelvis, ribs, skull, and lower part of the spine, and it seems necessary to assume that tumours in these situations must have arisen from detached thyroid cells carried by the circulation.

As bearing on this hypothesis, Joll's table mentioned below brings out the significant fact that the bones least likely to include aberrant thyroid tissue are most commonly the seat of metastasis, and of the 44 cases the skull and spine were involved 15 and 12 times respectively, as opposed to the clavicle and sternum 7 and 3 times.

3. *The chief evidence in favour of metastasis from a normal or benign thyroid* is derived from a series of cases reported by various observers where a thyroid tumour in bone has been associated with either a clinically normal thyroid or with some benign condition such as a colloid or adenomatous goitre. Joll<sup>6</sup> has recently tabulated a comprehensive list of these two types, adding a case of his own and making some instructive comments.

The first group is admittedly small, barely reaching double figures, and must be accepted with great reserve in view of the fact that the cases have rarely been checked by an examination of the cervical thyroid that stands criticism. Ewing indicates his scepticism by pointing out that in none of these cases has the supposed normal thyroid been submitted to microscopical examination, and Albert Kocher<sup>7</sup> takes a similar attitude.

The second group, in which a metastasis from a colloid or adenomatous goitre is postulated, is a much larger one. Many of the cases are open to criticism, and even Cohnheim's case, which is classical in that it gave the start to the conception of benign metastatic goitre, was not accepted by some of his contemporaries. In this case the thyroid was generally enlarged and was the seat of a gelatinous or colloid change, and the metastatic tumours in the spine, femur, and lungs were of the same type. Autopsy showed that a portion of the colloid growth had penetrated the wall of one of the inferior thyroid veins. Under such circumstances transplantation of thyroid tissue would readily occur, but it seems necessary to assume an abnormal growth activity on the part of the colloid goitre to enable it to penetrate the wall of the vein. Wöller<sup>8</sup> expressed his opinion of these cases in words difficult to contravene: "When the glandular cells distributed by metastasis have given rise, in different situations, to tumours which not only grow but exert a destructive action on the bone, the primary tumour should be considered benign neither clinically nor anatomically, even if its malignancy cannot be established by microscopic examination."

It is the writer's object not to embark on any critical analysis of the recorded cases, but to emphasize the facts, which may appear obvious, that physical examination of the neck during life is entirely unreliable, and that superficial inspection of the thyroid at autopsy may readily fail to reveal minute changes within the gland (*see Fig. 252*); and further, to demonstrate by microphotographs that a secondary thyroid tumour of bone of unquestionable malignancy may display a structure, foetal or adult, hardly if at all distinguishable from that of a normal or benign gland. In such a cellular organ as the thyroid, where the cell content is subject to great variations, both in quality and quantity, within the range of the benign, the difficulty in determining the onset of an early malignant change is greatly enhanced, and the interpretation of the finer shades of malignancy is likely to remain a matter of personal opinion. The extreme view that it is only by complete or even serial section of the thyroid that minute foci of proliferation can be excluded is logically unassailable, but is beyond the range of the practical, and even if carried out would hardly yield any unanimity of opinion in so difficult a field.

### THE MATERIAL.

The material available for discussion in this paper is admittedly too scanty for more than tentative conclusions, and is derived from three cases only, but of differing clinical types, which may be briefly summarized.

*Case 1* had a frankly malignant goitre on first coming under observation, and in addition had a secondary deposit in a rib.

*Case 2* presented the features of a simple enlargement of the thyroid for several years, with recent rapid growth of one lobe as the only suspicious feature, early malignant change being discovered on section and with the microscope. A secondary deposit appeared in the sternum two years after removal of the affected lobe, and, when the patient presented himself for further treatment after the lapse of another two years, the tumour in the manubrium had reached the size of an orange.

*Case 3* presented no abnormality of the thyroid discovered during life, metastases manifesting themselves by pathological fracture of the right femur and great enlargement of the left ilium, the thyroid nature of these tumours only becoming evident at autopsy and on microscopic examination. This is the most interesting and important of the three cases, for it belongs to the type that has been the chief prop of the hypothesis that a normal or benign thyroid may give rise to metastasis. All three cases have direct practical bearings.

*Case 3* illustrates the important principle that in dealing with an endosteal tumour the possible well-known secondary sources of origin such as the thyroid, breast, prostate, and kidney should be excluded before accepting the tumour as primarily osseous. This is a counsel of perfection, and in the case of a secondary thyroid deposit with no clinical change in the neck the exact nature of the bony tumour can only be determined by exploratory operation. The case is a striking illustration of the futility of depending on a physical examination of the neck to exclude a thyroid origin in the case of a doubtful tumour of bone, for the thyroid showed no abnormality, and only on microscopic examination was unequivocal evidence obtained that the thyroid had given origin to the tumours in the femur and ilium. The writer has recently

observed another case exemplifying the same point. This patient, an elderly man, was referred to the surgical wards for the removal for diagnostic purposes of a hard, enlarged gland in the left supraclavicular region. No primary source was detectable in the abdomen or neck, but microscopic examination showed the gland to be infiltrated with adenocarcinoma of unmistakably thyroid character. Even with this knowledge a further examination of the thyroid was entirely negative. Though an origin from aberrant thyroid tissue is possible in this case, it seems more reasonable to suppose that the parent source in the thyroid gland is still too small to be detectable by palpation.

Cases 1 and 2 illustrate the practical difficulties of this subject when a surgeon is confronted with the problem of dealing with a *single* thyroid metastasis in an accessible situation. How little guidance he obtains from the pathological confliction of ideas is best illustrated by quoting Jaeger,<sup>9</sup> who lays down the following four sets of conditions relative to the thyroid and the metastasis: (1) Malignant thyroid—benign metastasis; (2) Benign thyroid—malignant metastasis; (3) Malignant thyroid—malignant metastasis; (4) Benign thyroid—benign metastasis.

If a surgical belief is based on the first set of conditions, the natural desire to do the best for the patient is strengthened by pathological support, and operation receives full justification if the primary tumour in the neck can be removed. The second set of conditions reduces the problem essentially to that of any primary malignant tumour of bone, with the addition that the benign (*sic*) source also requires attention. The third set renders the problem practically hopeless, and the fourth is the combination that all surgeons would prefer to meet.

Reducing the matter to the practical, and glossing over the lingering uncertainty as to the existence of other latent deposits not revealed by a searching radiographic examination, we may have to deal with a *single metastasis in an accessible situation*: (1) That develops after the removal of a thyroid tumour of low malignancy, of which Case 2 is an example; (2) That is associated with a condition of the thyroid such as an adenomatous or colloid tumour which lends itself to removal with every prospect of success; (3) That is associated with a clinically normal thyroid where the exact nature of the bony tumour must remain uncertain till exploratory operation; and (4) That is associated with a definitely malignant goitre which can be removed or is treated by radium or other means. Under these sets of conditions, with the possible exception of the fourth, operation on the osseous tumour is certainly indicated, and in most cases, especially in view of the existing uncertainty as to the exact status of the metastasis *qua* malignancy, should be of a conservative nature.

#### CASE REPORTS.

Case 1.—Male, age 52. Complained of pain at the root of the neck, passing round the neck and up the sides of the head, of two months' duration, also pain over the ribs on the right side, of several weeks' duration. Examination showed a considerable enlargement of the thyroid, especially on the right side, and the gland was hard and adherent. Over the eighth rib, below the angle of the right scapula, there was a hard nodular swelling the size of a chestnut, evidently growing from the rib. The secondary deposit was excised along with several inches of rib, but the goitre was found inoperable on exploration, and the wound was closed with a view to future treatment by radium.

**THE COSTAL METASTASIS.**—On splitting the rib a small, solid, fleshy tumour was found expanding and replacing it.

**Microscopical.**—Generally it presents the features of an adenocarcinoma, destroying and replacing the bone. The cells are mostly spheroidal and are arranged irregularly, though in places they show an attempt to form acini with no lumen or duct-like spaces. There is no trace of colloid, and the general picture gives little suggestion of a thyroid origin, though presenting a superficial resemblance to foetal thyroid tissue, the solid clumps of columns of cell resembling those of a foetal adenoma (Fig. 248).



FIG. 248.—Case 1. Costal metastasis. Adenocarcinoma; shows typical structure, bearing a crude superficial resemblance to that of a foetal adenoma.

It is unfortunate that the primary tumour is not available for comparison with the secondary deposit, but the enlargement, hardness, and fixation left no doubt as to its malignant nature.

**Case 2.**—Male, age 47. Noticed slowly increasing enlargement of the neck for eight years, and applied for treatment owing to a rapid increase in growth on the left side during the last year. Examination showed a symmetrical enlargement of the thyroid, the left lobe displacing the larynx markedly to the right. The enlarged left lobe was resected, the patient

making a smooth recovery and returning to his occupation in Caithness. A diagnosis of early malignant change was made on microscopic examination. Two years later he noticed a swelling the size of a pigeon's egg in the upper end of the breast bone, which caused him so little discomfort that he delayed seeking further treatment for another two years, by which time the tumour in the manubrium had reached the size of an orange. As there was no return of the tumour in the neck and the sternal metastasis appeared to be the only one, it was decided to remove it.

**OPERATION.**—The muscular attachments to the sternum were divided, the 1st, 2nd, and 3rd costal cartilages cut through on both sides, the sternoclavicular joints disarticulated, and the sternum was sawn across between the 3rd and 4th ribs. At this stage the patient's condition became precarious, and the wound was packed with the object of completing the removal at a second stage; but he gradually sank, and died the same evening.

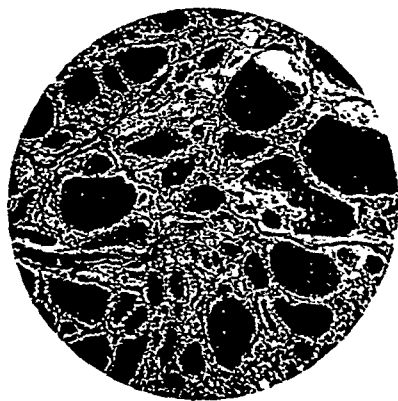
**THE THYROID.**—The resected left lobe was considerably enlarged, and on section showed marked pathological changes. Its medial part was occupied by a cyst the size of a Tangerine orange, while the solid peripheral part was sharply divided into an area composed of spongy tissue containing colloid, and a larger pale area containing scattered hæmorrhages and not unlike encephaloid cancer, giving the impression that a malignant change had been superimposed on a colloid cystic goitre.

**Microscopical.**—The spongy tissue shows the features of a simple colloid goitre. The pale, more or less solid area shows in parts marked proliferation and changes in the character of the glandular epithelium, though maintaining the characteristic thyroid structure to such an extent that a cursory examination of one area might fail to note the departure from the normal, or, in other words, might class it as a benign condition. Many of the alveoli are well formed, and are lined by cubical cells secreting colloid. The chief change appears to affect the inter-alveolar cell groups, and in some areas these form solid cellular patches enclosing here and there

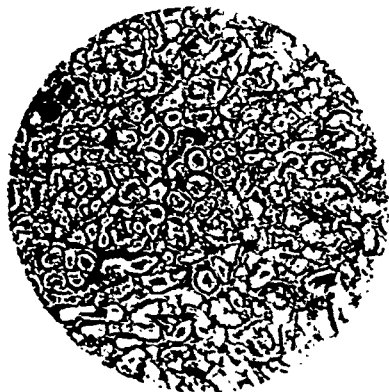
small alveoli containing no colloid. The cells generally are larger than normal and stain poorly, and the nuclei are unusually large (*Fig. 249*).

It is noteworthy, as indicating the low grade of malignancy, that no recurrence took place in the remains of the thyroid in the four years between the first and second operations, and microscopical examination of the right lobe and isthmus after death showed merely the features of a simple colloid goitre.

**THE STERNAL METASTASIS.**—Generally it presents the picture of an adenocarcinoma destroying and replacing the bone, but shows considerable structural variations in different parts. The bulk of the tumour is made up of tissue presenting a general resemblance to the undeveloped thyroid, consisting of columns and clumps of cells suggesting an acinar arrangement without a lumen. In certain areas the cells assume an alveolar arrangement so definite as to render a thyroid origin unmistakable, though colloid is absent. The cells are either irregular or of the characteristic cubical shape. In the areas where active destruction and replacement of bone is going on, the type and arrangement of the cells are so irregular as to make the diagnosis of adenocarcinoma obvious. To summarize, the metastasis exhibits variations in structure, ranging from undeveloped thyroid tissue to definite



**FIG. 249.**—*Case 2.* Thyroid. Adenocarcinoma; but preserving a superficially benign appearance. The alveoli are still fairly uniform and contain colloid, but the cells for the most part differ from the normal and show a tendency to form solid patches.



**FIG. 250.**—*Case 2.* Sternal metastasis. Adenocarcinoma. The majority of the cells are arranged in solid groups, but commencing alveolar formation is evident.



**FIG. 251.**—*Case 2.* Sternal metastasis. High-power view showing general structure and tendency to the formation of alveoli lined by cubical cells. Note broad resemblance to developing fetal adenoma.

adenocarcinoma, with here and there an attempt to reproduce the normal glandular features (*Figs. 250, 251*).



*Case 3.*—Female, age 48. Had complained of pain in the right hip-joint and difficulty in walking for several months. While confined to bed, the upper end of the right femur fractured spontaneously. A swelling became manifest in the groin, and pain was referred to the distribution of the femoral nerve, and was later succeeded by numbness. A skiagram revealed a fracture of the neck of the right femur, with marked rarefaction of the head and upward displacement of the trochanter. A tumour then developed in the left iliac region and gradually increased in size, œdema of the lower extremities became marked, and death took place two and a half years after the onset of the illness.

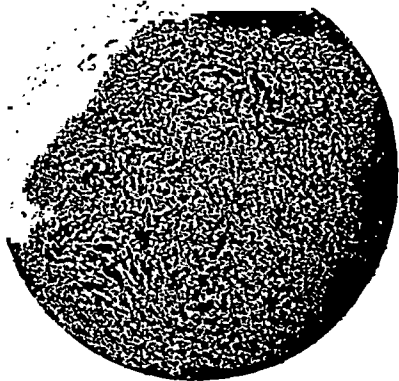
The post-mortem findings are described below. It is noteworthy that metastasis involved the bones alone, the lungs and lymph nodes escaping.

**THE THYROID.**—The gland at autopsy showed neither general nor local enlargement, and superficial examination revealed no departure from the normal; but on section the right lobe was found to contain three nodules about the size of a filbert. Two of these were hard and apparently fibrous, and the third resembled an ordinary adenoma.

*Microscopically*, the main part of the gland shows a more or less normal thyroid structure. The fibrous areas, however, display definite changes. They consist

chiefly of fibrous tissue, but enclose masses of glandular cells which differ markedly from those of a normal thyroid or of a typical encapsulated benign adenoma. The cells for the most part have lost their cubical shape and become spheroidal, and are arranged irregularly, but in some areas have a tendency to assume a tubular or alveolar disposition. The vascular network is unusually prominent, and the blood-spaces are large and thin-walled and of the character of sinusoids, the lining endothelial cells being in close relation to the glandular epithelium. Here and there the fibrous capsule contains small groups of compressed thyroid cells, and this may be interpreted either as an attempt to invade the capsule, or to represent outlying portions of thyroid tissue undergoing strangulation.

To summarize, the highly irregular arrangement and change in shape of the cell, the absence of colloid, and the embryonic character of the blood spaces strongly suggest a malignant adenoma (*Figs. 252, 253*).



**FIG. 252.**—*Case 3.* Thyroid. Malignant adenoma. The entire proliferating nodule enclosed in fibrous tissue appears in a single low-power field. Several similar areas were present in other parts of the gland.



**FIG. 253.**—*Case 3.* Thyroid. High-power view of same, showing the sinusoids and the shape and arrangement of the thyroid cells.

## THE METASTASES IN THE RIGHT FEMUR AND LEFT ILIUM.—

*The femur*: The head, neck, and both trochanters were completely destroyed and replaced by a large cavity filled with chocolate-coloured fluid, while the acetabulum was filled by a soft, friable, tumour-like material. On section of the femur, the tumour was found to have extended for some distance into the medullary cavity, where it displayed cystic areas.

*The ilium*: The greater part of the left ilium was completely destroyed by tumour formation, and the iliac fossa was occupied by a large mass which partially filled the pelvis and lay deep to the iliacus and psoas muscles. The left sacro-iliac was disorganized as the result of erosion by the tumour. On section, the mass was found to be cystic, and its appearance was highly suggestive of a cystic goitre.

To summarize, the destructive changes in both femur and ilium were on so marked a scale as to leave no doubt as to the highly malignant character of the invading deposits.

### *Microscopic Features.*—

*The femoral metastasis*: The solid tissue replacing the upper end of the bone shows for the most part a structure resembling undeveloped and badly-formed foetal thyroid. The cells are arranged in small groups and columns. An acinar arrangement is easily distinguished, and in some areas the alveoli are well formed, are lined by cubical cells, and contain thin, badly-staining colloid—the thyroid character being unmistakable. Certain areas show a structure exactly reproducing that of the nodules in the thyroid gland already described, with the same tendency to invade the fibrous stroma.

*The iliac metastasis*: The tumour replacing the ilium shows a generally similar structure, but the formation of vesicles like those of the normal thyroid is in parts much more evident, and in small areas reproduces the features of an ordinary colloid goitre, giving the impression that when the fungating tumour is liberated from the mechanical restraint exercised by the rigid bony tissue, it tends to undergo colloid hypertrophy, while the tissue actively eroding the fibrous and osseous structures retains an undifferentiated type.

To summarize, the thyroid nature of the secondary deposits is everywhere evident, but displays striking variations. The foetal element predominates, and is hardly distinguishable from the normal developing thyroid; vesicular and colloid formation of the normal type is well marked; and in some areas the structure of the suspicious nodules in the cervical thyroid is exactly reproduced. Certain areas might well be regarded as displaying a benign structure, and illustrate the peculiar tendency of secondary thyroid deposits of a cancerous nature to revert to the normal: but no tumour displaying such obvious malignant tendencies as described above can seriously be regarded as benign (*Figs. 254, 255, 256, 257*).

The histological appearances of secondary thyroid deposits in bone, as portrayed in these three cases, display considerable variations, and this variability depends partly on the type of the parent tumour, partly on the duration of the metastasis, and partly on its local circumstances. One would suggest that in the early stages of a metastasis enclosed within bone the structure is likely to remain of an undifferentiated embryonic type. Later on, the striking tendency of the aberrant thyroid cells to arrange themselves in a more or less normal fashion asserts itself, and this tendency becomes all the more evident if mechanical restraint is removed, when the features of colloid hypertrophy may be superadded. In other words, the life history of a metastasis is likely to follow that of the developing cervical thyroid. Like it, the metastasis may function, as in the much-quoted case of von Eiselesberg,<sup>10</sup> and similarly it may undergo colloid or cystic changes. Hence the examination of one part of an osseous deposit, or examination at one stage of its

development, may prove misleading, owing to the facility with which the thyroid cells assume structural variations.

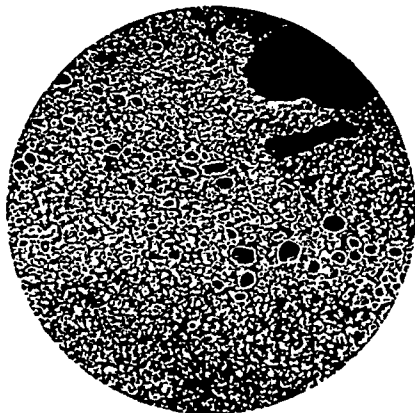


FIG. 254.—Case 3. Iliac metastasis. Shows the general structure typical of both this and the femoral metastasis. Solid groups of cells preponderate, but early alveolar formation of a regular type with colloid is well seen.



FIG. 255.—Case 3. Iliac metastasis. Shows various stages in development; solid groups of cells, small alveoli containing colloid, and dilated alveoli filled with darkly-staining colloid.



FIG. 256.—Case 3. Iliac metastasis. High-power view showing changes characteristic of a simple colloid goitre.



FIG. 257.—Case 3. Iliac metastasis. Another area showing well-marked alveoli of uniform size with commencing colloid formation.

Figs. 254 to 257 are reproduced to show the tendency of the metastases to revert to a normal or benign structure; but, as noted in the text, other areas exactly reproduce the structure of the nodules in the thyroid, and are regarded as certainly malignant.

The tendency displayed by secondary deposits of a carcinomatous nature to assume a structure resembling that of the normal thyroid—a feature first emphasized by Eberth and designated “the return towards the normal”

by French writers—requires most careful consideration before a secondary tumour can be accepted as having a normal or benign structure, and more stress should be laid upon the reaction produced by the deposit on the surrounding tissues and its capacity of eroding and destroying the bone than upon its histological characters.

### SUMMARY.

The material is too scanty to permit of any formal 'conclusions', but the cases raise certain points which merit consideration :—

1. Metastatic tumours of bone of thyroid origin exhibit considerable histological variations.

2. An embryonic or foetal structure appears to form the basal type, and this may develop towards a normal thyroid structure with formation of colloid, or may assume frankly malignant characters. All these variations may be represented in the same tumour.

3. The fact that secondary tumours may exhibit a striking tendency to the formation of a structure practically indistinguishable from that of the normal or benign thyroid—"the return towards the normal"—probably provides an explanation for some of the so-called benign metastatic tumours.

4. This feature should be coupled with the fact that the proliferative changes in the thyroid indicative of malignancy may be so minute or even microscopical as to be readily missed in the absence of a thorough histological examination, and still more readily if reliance is placed on a clinical examination.

5. The sinusoidal character of the thyroid circulation, seen to great advantage in adenomata, may have a direct bearing on the origin of benign metastatic tumours.

6. The true criterion as to the benign or malignant nature of thyroid osseous deposits should be based on their destructive behaviour towards the surrounding bone rather than upon their histological characters.

Cases 1 and 2 were under the care of the late Professor Alexis Thomson in the Royal Infirmary, Edinburgh, and for the records of Case 3 I am greatly indebted to Dr. H. D. Wright, now of University College Hospital Medical School.

The microphotographs are the work of Mr. Pettigrew, Technical Assistant in the Department of Surgery, Edinburgh University.

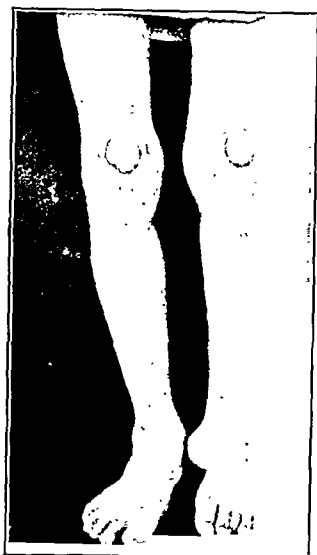
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- <sup>8</sup> WÖHLER, *Arch. f. klin. Chir.*, 1883, xxix, 38, see also 754.
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- <sup>10</sup> VON EISELSBERG, *Arch. f. klin. Chir.*, 1894, xlviii.

## A NEW TECHNIQUE FOR ARTHRODESIS OF THE TARSAL JOINTS.\*

By ALEXANDER MACLENNAN, GLASGOW.

THE problem of dealing with a paralytic foot resulting from infantile paralysis has been adequately solved by the performance of arthrodesis as recommended by Dunn. Unfortunately these cases are often complicated by deficiency in growth of the entire leg, and especially in that part of it below the knee. In such cases (*Fig. 258*) there is little benefit to be gained by stabilization of the tarsal joints. An arthrodesis of the ankle-joint added to that of the tarsal joints, with fixation of the foot in extreme extension (equinus position), is then advisable, as it adds the length of the foot to that of the leg.



*FIG. 258.*—To illustrate the condition suitable for this operation.

This operation as described by Mikulicz adequately fixes the foot, but it necessitates the resection of the tarsus, and thereby fails to gain the full possible lengthening of the leg. The operative technique about to be described has the advantage of producing the minimum of shortening of the foot, and, while it fixes the os calcis, also allows of some pressure being put on the heel, and so reduces that on the balls of the toes. This operation should not be performed until the patient has reached nine years of age, unless it be combined with a graft of bone extending from the tibia to the metatarsus.

In children under nine years much of the tarsal bone is cartilage; hence an arthrodesis is difficult to achieve in them. During the period of waiting, the foot is put up if necessary in successive plaster-of-Paris casings until a complete equinus position is obtained. Finally, a celluloid splint is moulded to a cast of the foot, and the child becomes accustomed to walk on the balls of the toes until the requisite age is reached.

The operation is carried out as follows: A tourniquet is applied to the thigh. A dorsal incision to the outer side of the long flexor of the great toe extends obliquely upwards from the space between the heads of the first and second metatarsal bones to the lower tibio-fibular joint. This incision reaches

\* A communication made to the Association of Surgeons, Liverpool, May, 1924.

down to the bones, avoiding as much as possible the dorsal cutaneous nerves and the dorsalis pedis artery. The tendinous slip of the short extensor passing to the great toe crosses the incision; it is not worth while conserving it. The first and second metatarsal bones are separated by the knife from each other, a saw or osteotome is inserted, and the cuneiform, scaphoid, and astragalus are split vertically. In such feet the bones are usually much rarefied and soft. By the aid of retractors the split in the foot is forcibly widened, exposing all the joints (*Fig. 259*). The various joints are erased by the osteotome and sharp spoon. The only difficulty in the operation

will be found in rendering the obliteration of the astragalo-calcaneal joint complete. If pieces of the very friable bone become detached during the operation,

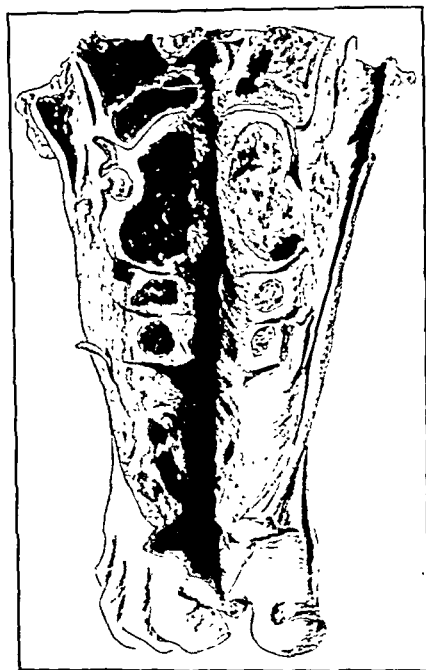


FIG. 259.—Specimen of split-foot from a child of 5 years, showing the free access to the tarsal joints.

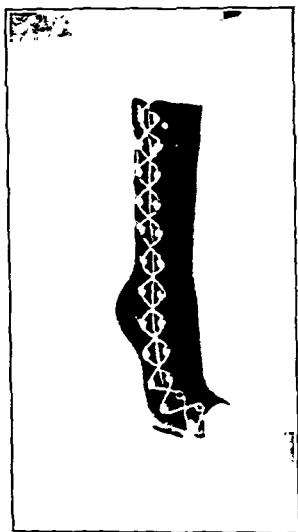


FIG. 260.—Shows arthrodese foot in celluloid case.

they should be carefully preserved, and should be inserted into the wound before the incision is closed. Ligatures are not usually required, as the hæmorrhage is not serious. A few subcutaneous catgut sutures may be inserted, and the wound closed. The foot is put up with a lateral straight wooden splint, to be followed, when the sutures are removed in a fortnight's time, by a plaster-of-Paris case, which should be retained for eight weeks. After six weeks the child should be encouraged to walk, so as to stimulate the formation of the bone. A celluloid splint should then be fitted as shown in *Fig. 260*.

In none of the cases have there been any untoward symptoms. Little pain is complained of, and there has been practically no hæmorrhage. The external appearance of the foot is unaltered, and its length not appreciably

diminished. When fixation has been achieved, after a lapse of about six months, an artificial boot may be made so as to distribute the pressure between the projecting heel and the balls of the toes. The various illustrations will render further description of the procedure unnecessary (*Figs. 261, 262, 263*).

Altogether seven cases have been done on children between the ages of 10 and 12. In the first case the incision extended from the middle of the sole of the foot, between the first and second toes, up to the ankle-joint. The incision has now been curtailed to the dimensions referred to, as an incision



**FIGS. 261, 262.**—To show foot after splitting operation.



**FIG. 263.**—Radiograph of foot shown in Fig. 261 6 months after operation.

into the sole of the foot was found to be unnecessary. The children walk without support of any kind other than a stiffened boot.

The only alternative to the operation would seem to me to be amputation.

**CYSTINURIA WITH CALCULUS FORMATION.**

BY HAROLD C. EDWARDS, LONDON.

CYSTIN calculus must be an extremely rare condition. Since Woollaston first discovered a cystin stone in the bladder of a child in 1810, only some 117 cases have been recorded. It is computed that  $2\frac{1}{2}$  per cent of cystinurics develop stones, but this figure is probably high on account of the large number of unrecognized cases of cystinuria. The following case is of additional interest in that the passage of cystin crystals by the kidney is intermittent.

The patient is a man of 36, of medium height and build, giving a history of quinsy when three years old, and with nocturnal enuresis up to the age of seven. He first suffered symptoms of stone in 1901, when he had a severe attack of renal colic, and passed small stones per urethram. Two years afterwards he was operated upon for acute appendicitis with abscess. From 1903 to the present time he has had numerous attacks of renal colic, and has passed a large number of stones varying from minute dimensions to the size of a pea. The attacks have occurred at intervals of varying duration, sometimes of two to three months up to nine to twelve months. An attack may last anything from two hours to six weeks. In the long attacks, pain is subacute, with severe exacerbations.

He has always suffered from a weak digestion, and during the last twenty years—i.e., since the incidence of the renal complaint—he has been troubled with flatulence and a feeling of weight in the epigastrium. This is greatly exaggerated before an attack of renal colic, and forms an actual prodroma. Blepharitis, with much blepharospasm, and profuse watering of the eyes, are also prodromata. This condition reaches a climax during the renal attack, and slowly subsides.

He has often suffered from rheumatism affecting both knees. For some years he has suffered occasional attacks of acute inflammation, with much pain and swelling of the first joint of either big toe. This seems most liable to occur in the early days of spring, and simulates gouty arthritis. During the early part of such an attack, which lasts about three weeks, it is agony to put the foot to the ground, and even the contact of bedclothes is intolerable. A radiograph of the joints was negative.

He suffers from numbness of the arms on waking, frequent tremors, cramps at the backs of the knees, and a habit spasm of the arm when walking or driving. He is much addicted to talking in his sleep. Two years ago he suffered an attack of herpes in the scalp. He occasionally suffers from *acne vulgaris* on the back and shoulders.

In 1906, as a result of the first operation of litholapaxy, he developed an epileptiform attack, which recurred in two, three, or six months, and always happened during sleep. The interval lengthened until the attacks completely



disappeared some twelve years ago. Litholapaxy had been performed some eight times in all up to the time of admission.

EXTRACT FROM MEDICAL REPORT, JULY 11, 1922.

*Examination of Faeces :—*

Undigested muscle fibres	..	..	Nil
Undigested fats	..	..	Nil
Fatty acids and soaps	..	..	Nil
Undigested starch	..	..	+
Ova and parasites	..	..	Nil
Occult blood	..	..	Nil
Crystals	..	..	Nil
Organisms on culture	..	..	A high proportion of streptococci and diphtheroids.

*Examination of Blood :—*

Hæmoglobin	..	..	95 per cent
Total red cells	..	..	5,670,000 per c.mm.
Colour index	..	..	0.84
Total white cells	..	..	6,400 per c.mm.
Lymphocytes	..	..	35.0 per cent
Polymorphs	..	..	55.0 "
Eosinophils	..	..	1.0 "
Large mononuclears	..	..	7.0 "
Mast cells	..	..	1.0 "
Myelocytes	..	..	1.0 "
Total cells counted..	..	..	200
Arnth index of polymorphs	..	{ 1 2 3 4 5	5 34 40 19 2 per cent
Average per cell (normal : 2.76)	..	..	2.79
Iodophilia	..	..	Nil
Calcium index	..	..	Nil
Malarial parasites	..	..	Nil

*Results of Urine Analysis :—*

Source	..	..	24 hours
Specific gravity	..	..	1012
Urea (normal 2.2 per cent)	..	..	0.8 per cent
Total acidity (normal urine = 2 c.c.	..	..	
N/1 NaOH per cent)	..	..	1.0 c.c. per cent
Albumin coagulable	..	..	Nil
Xanthoproteic reaction	..	..	Nil
Sugar—Benedict's test	..	..	Nil
Acetone and diacetic acid (Rothera's test)	..	..	Nil
Amino-acid derivatives :			
Tryptophane as Skatoxyl	..	..	Nil
" " Indican	..	..	+
" " Indirubin	..	..	Nil
" " Indol	..	..	Nil
Tyrosine " Tyramine	..	..	+
Bile salts	..	..	Nil
Bile pigments	..	..	Nil
Phosphates on boiling	}	..	Nil
" " neutralization		..	
Organisms	..	..	Streptococci and <i>B. coli</i>
Deposit on cooling	..	..	Slight
" " centrifuging	..	..	Pus cells and organisms. No cystin crystals were observed.

*Family History.*—Father, age 82, and mother, age 80, are still living, and enjoy reasonable health. They were not related before marriage.

One brother and two sisters suffered from similar kidney calculi :

- (1) One sister died after having one kidney opened some years ago.
- (2) A second sister had her right kidney removed about four years ago and has apparently had no further trouble, although she is in a state of chronic ill health. The kidney was enormously enlarged and adherent to stomach and bowels, and over two hundred cystin stones were found in it.
- (3) A brother two years senior has an abscess in one kidney and stones in the other.

The patient has three children, and states that the oldest girl has the same sediments in her urine as he has himself.

Patient was admitted to King's College Hospital in February, 1924. He felt there was a large stone in his bladder which he could not pass per urethram.

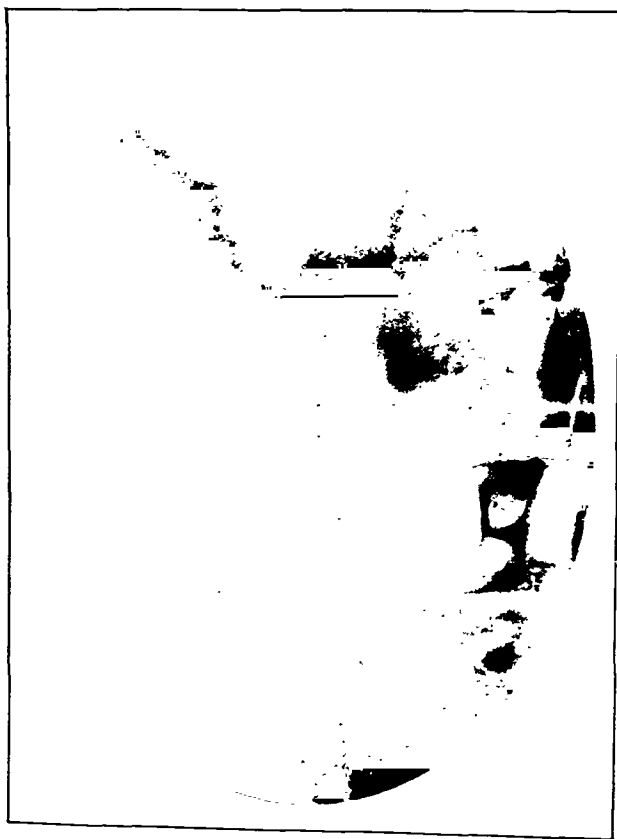


FIG. 264.—The radiograph shows a small collection of cystin stones in the lower pole of the left kidney.

He brought up a few of some dozen small stones which he had recently passed. They are small rough bodies, the size of a large pea, of yellow colour and waxy appearance. Analysis of one showed it to be entirely composed of cystin.

X rays showed a small collection of stones in the pelvis of the left kidney, with one low down in the ureter and two in the bladder—a large and small one (Figs. 264, 265).

The urine was pale yellow, and slightly turbid and oily. There was a slight yellow deposit. Reaction was alkaline. Much pus was present, and *Staphylococcus albus* and *Bacillus coli* were cultivated. No cystin crystals were found in the urine even after acidifying with acetic acid and acetone. The chemical reactions of cystin were absent.

The large stone was crushed by Sir John Thomson-Walker under stovaine, and shortly afterwards the small stone seen in the skiagram was passed. The patient left hospital the next day.

Repeated specimens of urine were sent up by the patient, but no cystin



FIG. 265.—One stone is shown in the bladder, another in or near the left ureteric orifice, and a third in the left ureter a short distance from the orifice.

was found on daily examination. On April 14, almost two months after litholapaxy, a specimen was received by post which contained cystin crystals in abundance. The specimen was different from those previously received. It was darker, more oily, and yielded a heavy deposit. It had a sweetish odour. Pus cells were abundant. On standing for a few days, the characteristic smell of hydrogen sulphide developed. Cadaverin and putrescin were looked for in this specimen by benzoylation, but I could detect none.

Specimens received from the parents contained no cystin. The urine of all three children was dark and yielded a heavy deposit. No cystin was found in either, but very characteristic tyrosin crystals were found in the urine of the youngest child, a girl of 4.

The patient lives some hundred miles away, and experimental work is impossible. As far as it has been exploited, the case seems to add little further to our present knowledge of the subject, beyond the fact that it definitely establishes a condition of intermittent cystinuria. Two years ago, a very thorough search for cystin in the urine was negative. For two months only one specimen was obtained in which it was found. All specimens were searched regularly without result until the specimen received on April 14 showed cystin in abundance. Two cases of temporary cystinuria have been previously recorded by Warburg, and Semon and Lewis.

The familial nature of the disorder is brought out strongly, particularly along horizontal lines, i.e., the brothers and sisters of the patient. The urine of the children is not above suspicion. Only one specimen from each child was examined, and although repeated attempts to find crystals bore no fruit, yet the urines were far from normal, and I think it highly probable that at some time or other cystin could be found. The discovery of tyrosin in the youngest child is hard to explain apart from cystinuria.

The gouty attacks lead one to think of Abderhalden's famous case of the infant who died of so-called 'inanition', and in whose tissues deposits of cystin

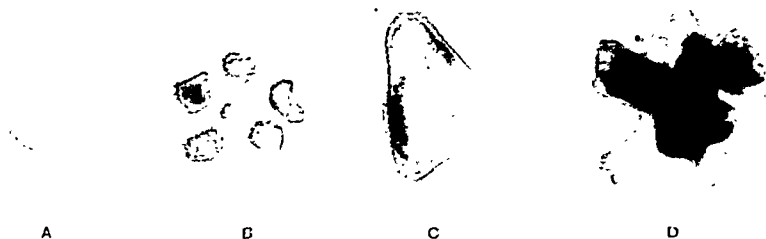


FIG. 266.—The print is of various urinary stones X-rayed simultaneously, to show their relative opacity. A, Oxalate. B, Phosphate. C, Collection of small cystin stones. D, Uric acid stone.

crystals were found. Although there is no definite evidence that the acute attacks of arthritis are in any way related to the error of metabolism, it seems reasonable to suspect an intra-articular deposit of cystin similar to the deposit of sodium biurate in gout.

The liability to skin disorders finds a parallel in the case described by Miller which displayed a 'stubborn urticaria'. Miller actually found cystin crystals in the blood.

The prodromal attacks of dyspepsia do not occasion much comment, but it is difficult to associate the attacks of blepharitis with the renal condition. In Tennant's case of a young woman, age 21, the only symptom beyond hæmaturia was that "her eyes filled with tears during urination". Reflex lachrymation can be readily understood, and probably occurred in the case quoted, but there is nothing to explain the blepharitis.

There is a popular conception that cystin stones cast a poor shadow with X rays. As Morris pointed out some years ago, cystin calculus is second only in X-ray opacity to oxalate calculus. The accompanying photograph (Fig. 266) shows a comparison between urinary stones given the same exposure.

Treatment, as in all disorders of metabolism, is disappointing. Rationally, treatment should be directed towards arresting the excretion of cystin by the kidneys as a prophylactic against calculus formation. Diet has little effect. It has been shown that ingestion of cystin by mouth has no influence upon the output of cystin by the kidneys, although it increases the output of organic sulphates. Cystin is soluble in alkaline media; thus, by keeping the urine alkaline, cystin crystals should not be formed. Klemperer and Jacoby state that administration of 6 to 10 grm. of sodium bicarbonate causes complete cessation of cystinuria. In cases in which stones have already been formed, this treatment is of no avail.

Choleic acid may be given—a treatment based on the hypothesis that endogenous cystin should normally become the taurin of the bile salts, and that its excretion as cystin is due to lack of choleic acid with which it can conjugate.

In this case, as in many quoted, bowel sepsis determines the pelvic infection which furnishes the irreversible colloid that glues the crystals into calculi. An attempt should be made, therefore, to allay fermentation in the bowel by intestinal antiseptics, such as salol and kerol, coupled with urinary antiseptics. A course of vaccines may be tried. In the case described, a vaccine was prepared from the faecal strains enumerated above, the dose rising from 0.1 c.c. to a maximum of 1.0 c.c., at intervals of from five to seven days. This treatment gave rise to an eczema which persisted throughout the course, and seemed to have little effect upon the condition.

The question of operative measures must receive consideration. The risks of nephrectomy in this case would, I think, be unjustifiable. Removal of the stones by nephrotomy would be useless. The infection of the pelvis would again determine the formation of new stones. Southam, however, states that cystinuria may cease with operation, and quotes a case which remained free from cystin for fourteen years after operation.

The case described is being treated with kerol and urinary antiseptics, and stones too large to be passed per urethram are dispersed by crushing as they arise.

I wish to thank Sir John Thomson-Walker for permission to investigate and publish this case, and Mr. C. P. G. Wakeley for his advice.

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## RETROPERITONEAL CATHETERIZATION OF THE URETERS.

By ANDREW FULLERTON, BELFAST.

It occasionally happens that for some reason it is impossible to catheterize the ureters by the ordinary method. The bladder may be so extensively ulcerated, or so irritable, that enough fluid cannot be retained; or the medium may be so clouded by blood, pus, mucus, debris, etc., that the ureteral orifices cannot be seen. The ureter, or its orifice, may be stenosed, displaced, or distorted by some local condition, as, for example, a tumour inside or outside the bladder. A fold, or some unusual conformation of the intramural portion of the ureter, or spasm, may prevent the passage of the catheter. A large endovesical prostate, or other projecting tumour, may also give rise to insuperable difficulties by placing the ureteral orifices out of view or out of reach. The operation about to be described was designed with the object of surmounting any of these difficulties.

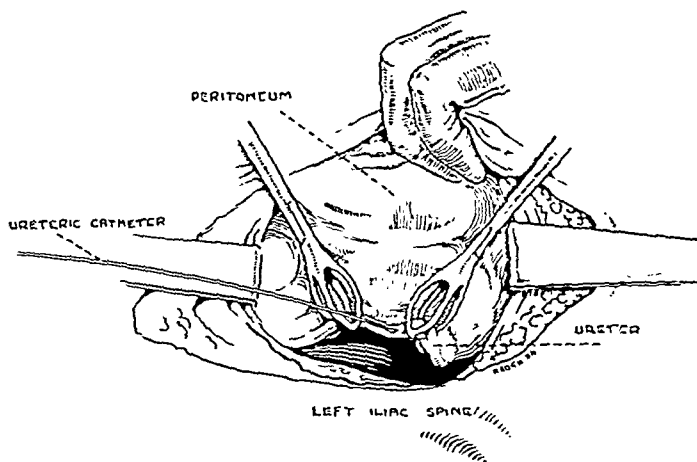


FIG. 267.—Showing peritoneum carrying ureter stripped back from pelvic wall. The ureter is shown fixed between two points by Lane's tissue forceps. The introduction of a ureteral catheter is shown. The segment of ureter between the forceps should be taut, and the ureter should be shown less curved on the right side of the figure. The catheter is entering a small slit in the longitudinal axis of the ureter.

An incision about 4 in. long is made in the lower iliac region, and the external oblique aponeurosis split in the direction of its fibres. After retraction, the internal oblique and transversalis muscles are similarly split in the direction of their fibres. The edges of the wound are now widely retracted, and the peritoneum is stripped from the iliac fossa and the lateral wall of the pelvis until the external iliac artery is reached. It will be found that the ureter has been reflected with the peritoneum, and can be recognized on its deep

surface as a thin strap, accompanied by longitudinal vessels. A section, about 2 in. long, of the ureter is steadied by two pairs of Lane's tissue forceps, each of which surrounds the ureter without damaging it. By traction on these forceps the required area of the ureter can be made taut, and brought, with the adherent peritoneum, towards the surface of the wound. A short longitudinal incision is made into the lumen, and a catheter introduced towards the renal pelvis (*Fig. 267*). This is done on both sides, and specimens are obtained from both kidneys. When sufficient urine has been collected, the small slit is accurately closed by a double layer of fine continuous catgut suture, excluding the mucous membrane. A small glove-drain is introduced, and the wound closed in the usual way.

This procedure was carried out in the following case, that of a male, age 45. About two years previous to my examination he began, rather suddenly, to suffer from frequency of micturition. This had continued ever since, and was accompanied by the passage of 'blood and corruption' in the urine. If he held his urine too long he had pain in the penis. During the night, if he fell asleep, he might retain for a maximum of two hours, but as a rule he was obliged to micturate every ten minutes, day and night. I examined him on Aug. 27, 1923. He appeared to be a strong, healthy man. Nothing could be made out on abdominal examination. Per rectum, he complained of pain on pressure over the base of the bladder. Nothing abnormal could be detected in the prostate or testes.

The urine was cloudy, alkaline, sp. gr. 1010, contained phosphates, pus, some blood-cells on microscopic examination, and a small amount of albumin. Sugar was absent. A few clumps of bacilli resembling tubercle bacilli were found in the urine, but the bacteriologist was not quite satisfied as to their identity. The bladder held, with great difficulty, about 2 oz. of fluid, and the patient strained and struggled so much that cystoscopy was almost impossible. The right side of the bladder appeared fairly normal. On the left side there was a good deal of redness, and the orifice of the left ureter was obscured by a small cystic swelling. There was a good deal of bleeding from the region of the neck of the bladder, which prevented a satisfactory examination. Attempts were made to catheterize the ureters, but although the points of the catheter engaged the orifices, they could not be passed farther. About a fortnight later, further attempts were made, after the injection of indigo-carmin subcutaneously and under an anæsthetic, but again without success. The ureters were then exposed in the iliac regions. The left side was first dealt with, and then the right. Both ureters were dilated and their walls were much thicker than normal. I attributed this to back pressure from compression of the intramural portion of the ureters by overaction of the bladder muscle. A small slit was made into each ureter, so as to admit a ureteral catheter, and specimens were easily obtained. On conclusion of the observation the openings were accurately sutured with fine catgut on a round needle, and the wounds in the parietes closed. Healing took place by first intention.

The specimen from the right side was slightly cloudy, with a blue tinge, was neutral in reaction, had a specific gravity of 1010, and contained a small amount of pus and a trace of albumin. An odd red cell and some ureteral epithelial cells were seen on microscopical examination. The chloride output

